Flat roofs and balconies

CHAPTER 7.1

This chapter gives guidance on meeting the Technical Requirements for flat roofs and balconies.

Waterproofing using profile sheet is outside the scope of this chapter.

NHBC

Raising Standards. Protecting Homeowners

Flat roofs and balconies 2020
CHAPTER 7.1

Definitions for this chapter

For the purposes of this chapter, the following definitions apply:

Flat roof	A roof with a maximum slope of 10° from the horizontal. Systems may be used at a greater pitch where they meet the requirements of this chapter, and materials are adequately held in place.
Deck	The structural substrate of the flat roof.
Decking	The upper trafficked surface of the balcony.
Warm roof	Insulated above the deck.
Cold roof	Insulated below the deck.
Inverted warm roof	Insulated above the waterproofing.
Intensive green roof	Vegetation contained within soil.
Extensive green roof	Vegetation contained in the sedum.

7.1.1 Compliance

Also see: Chapter 2.1

Flat roofs and balconies shall comply with the Technical Requirements.

Flat roofs and balconies which comply with the guidance in this chapter will generally be acceptable to NHBC.

Other sources of information include:

- BS 6229 'Flat roofs with continuously supported coverings. Code of practice'
- National Federation of Roofing Contractors (NFRC)
- Mastic Asphalt Council (MAC)
- Single Ply Roofing Association (SPRA)
- Liquid Roofing and Waterproofing Association (LRWA).

Where the flat roof or balcony is a terrace above another home, it should provide satisfactory acoustic performance in accordance with relavant building regulations.

7.1.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to all appropriate personnel.

Design and specification information should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- Extent and direction of falls, and position of rainwater outlets.
- Sections through the construction, indicating how falls are formed and ventilation is provided.
- Size, specification and position of the components, including treatments for durability and the position of the vapour control layer, insulation and waterproofing layers.
- Details at critical junctions.
- Details of fixings and fixing methods, including those for insulation and surfacing.
- Specification for intensive, or extensive green roofs.
- Details and fixing methods of balcony support and guarding components.

7.1.3 Flat roof and balcony design

Flat roofs and balconies shall support and transmit loads safely to the structure.

The structural design of flat roofs and balconies should:

- be produced by an engineer in accordance with Technical Requirement R5, and be in accordance with BS EN 1991-1-1, BS EN 1991-1-3 and BS EN 1991-1-4
- resist wind uplift by either being of sufficient self-weight or by being anchored to the main structure – where required, holding-down straps should be provided at a maximum spacing of 2m
- have adequate provision for the additional loads where a flat roof is to act as a roof terrace, roof garden or car parking area
- have adequate provision for movement in larger roofs, particularly where the span of the roof deck changes, e.g. in L-shaped buildings; joints should be continuous through the vertical upstands, walls and edges of the building
- include support steelwork and purlins which are square, true and free from twists or sagging.

Where joists and concrete roof elements are used to provide lateral restraint, they should:

- have a minimum bearing of 90mm, or
- have restraint straps at 2m centres (maximum) where joists or concrete beams are parallel to walls.

7.1.4 Timber and timber decks

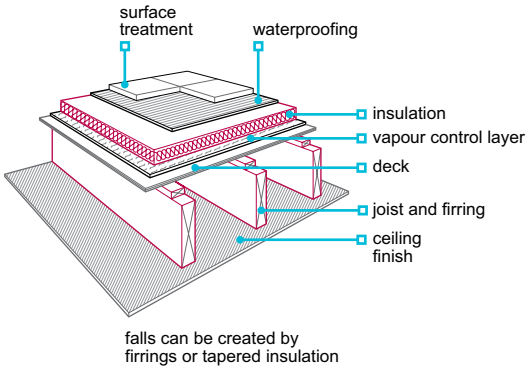
Timber flat roofs and balconies shall be of adequate strength and durability, and be installed to form a satisfactory substrate for the waterproofing system. Issues to be taken into account include:

a) structure and durability
b) joist hangers, straps and strutting
c) installing timber substrates.

Structure and durability

Timber should be:

- checked for conformity with the design upon delivery
- rejected where excessively wet, damaged or not of a suitable quality or shape
- stored under cover to prevent wetting
- preservative treated or naturally durable, in accordance with Chapter 3.3 'Timber preservation (natural solid timber)'
- retreated along the cut edges with a coloured preservative, where preservative treated timber has been cut.



Timber decks should:

- be in accordance BS EN 1995-1-1 or appropriate load/span tables published by TRADA in support of building regulations
- be from regularised timber, dry graded to BS 4978 and marked 'DRY' or 'KD' where softwood is used internally
- have I-joists or metal web joists specified in accordance with the manufacturer's recommendations and not used where any part of the joist is exposed to external conditions
- have joists which are sized and spaced in accordance with the design and at a maximum of 600mm centres
- be temporarily covered to prevent wetting, unless the waterproofing is to be installed immediately
- be level and, where necessary, using hard packing such as tiles or slates bedded in mortar to adjust joists (loose or soft packing, including timber, should not be used)
- formed with one of the materials listed in Table 1.

Table 1: Materials used for decks

Material	Thickness of deck (mm)	
	450mm joist centres	600mm joist centres
Plywood to BS EN 636, Class 3	15	18
Oriented strand board, type OSB3	15	18
Pretreated timber planking, tongue and grooved (close boarded timber) Maximum board width 100mm	19	19

Structural elements of balconies should have a service life of at least 60 years.

Timber in balconies should be limited to elements which are supported by materials other than timber. Timber should not be used for:

- gallows brackets supporting a balcony
- posts or columns supporting a balcony
- guardrails or their support
- cantilevered decks or joists
- infill joists.

Decking boards should be specified and fixed in accordance with:

- guidance from the Timber Decking and Cladding Association, or
- an engineer's design, in accordance with Technical Requirement R5.

Joist hangers, straps and strutting

Masonry carrying joist hangers should be level and at the correct height.

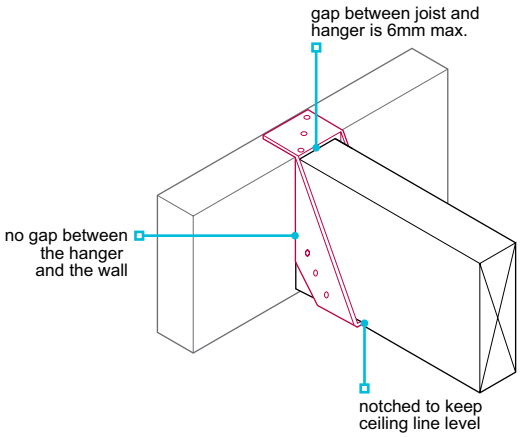
Mild steel straps and fixings should be protected against corrosion in accordance with BS EN 845-1.

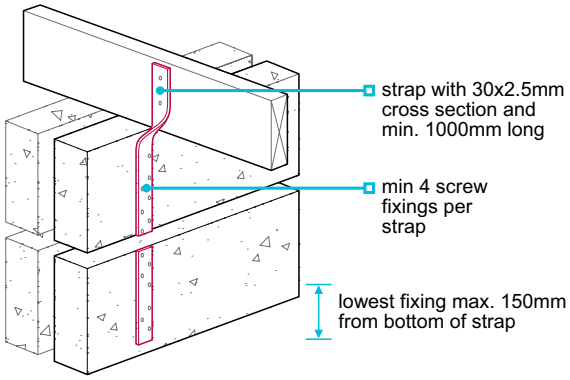
Joist hangers should be:

- in accordance with BS 845-1
- the correct size for the timber joist or trimmer
- fixed in accordance with the design.

Where holding-down straps are required to prevent the roof from lifting from the supporting structure, they should be:

- spaced at a maximum of 2m centres
- fixed with a minimum of four hardened nails 4mm in diameter x 75mm long, or No 12. wood screws x 50mm long, into plugs (where fixed to masonry)
- fixed with the lowest fixing secured within 150mm of the bottom of the vertical strap
- 30mm x 2.5mm and 1m long
- predrilled for fixings.





Strutting should be provided to prevent excessive movement, and::

- be either herringbone type (timber 38mm x 38mm), solid blocking (38mm thick timber x 0.75 depth of joist) or proprietary steel strutting
- not prevent cross ventilation in cold deck roofs.

Table 2: Spacing for strutting

Joist span (m)	Rows of strutting
Up to 2.5	None needed
2.5-4.5	One (at centre of span)
Over 4.5	Equally spaced along the span at maximum 2.5m centres

Installing timber substrates

When installing timber substrates:

- conditions should be dry, and materials protected from wetting until the roof is complete
- the area of deck installed should be of a size which can be quickly covered in the event of rain
- joints in sheet materials which are precovered or coated should be sealed immediately after fixing
- materials that have been damaged or adversely affected by moisture should be discarded.

Plywood and oriented strand board should:

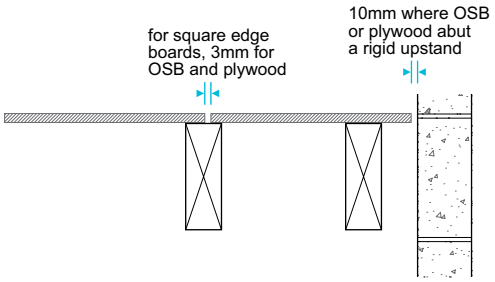
- have tongued and grooved boards installed with the long edge at right angles to the joists, and short edges supported on a joist or nogging
- have a maximum movement gap between boards of 3mm for square edge boards
- have a minimum movement gap of 10mm where boards abut a rigid upstand
- be supported on noggings where the edges of boards situated along the roof perimeter do not coincide with joists
- be fixed at a maximum of 100mm centres (unless the design specifies closer)
- be fixed with flat-headed ring shank nails (50mm long x 3mm for plywood, 3mm x 2.5 x board thickness for OSB).

OSB should be:

- installed over supports in the direction indicated on the boards, with the stronger axis installed at right angles to the supporting joists
- fixed a minimum of 9mm from the edge of the board.

Softwood tongued and grooved boarding should be:

- closely clamped together with end joints staggered
- fixed with two ring shank nails to each joist or firring, with nail heads punched below the timber surface.

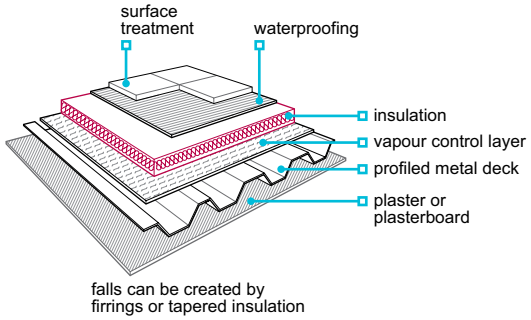


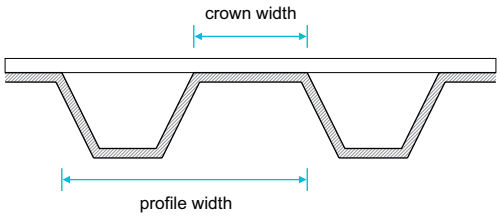
7.1.5 Profiled metal decks

Profiled metal flat roofs and balconies shall form a satisfactory substrate for the waterproofing system.

Profiled metal flat roofs should:

- be constructed to ensure they achieve the required strength and durability, and be checked for conformity with the design upon delivery
- be suitably stored to prevent damage
- comply with the manufacturer's load and span tables and the relevant applied safety factor
- resist loads in accordance with BS EN 1991-1-4 and be fixed in accordance with the manufacturer's instructions
- be galvanised steel to BS EN 10147 or aluminium to BS EN 485-2 and used in accordance with BS EN 1993-1-3
- have a crown which is a minimum of 50% of the profile width (for bonded systems)
- have a crown which is a minimum of 45% of the profile width (for mechanically fixed systems)
- be side stitched to ensure it performs as a continuous plane layer (unless the manufacturer recommends otherwise)
- be fixed and installed in accordance with the design and variations approved by the designer
- be adequately protected from construction loads
- be of suitable quality and finish before the waterproofing and insulation system is installed.





7.1.6 Concrete decks

Concrete flat roofs and balconies shall form a satisfactory substrate for the waterproofing system.

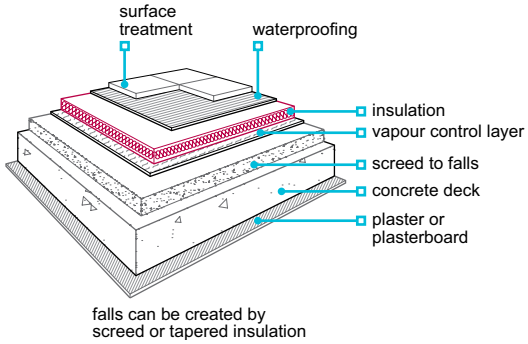
Concrete flat roofs should be constructed to ensure they achieve the required design, strength and durability, and be in accordance with BS EN 1992-1-1 and Chapter 3.1 'Concrete and its reinforcement'.

In-situ reinforced concrete decks should:

- be formed using a mix which has low shrinkage characteristics
- have accurately constructed and suitably supported formwork

Precast concrete decks should:

- be installed on an even and true supporting structure
- have a minimum 90mm bearing (unless the design specifies a smaller dimension)
- have allowance for continuity or anti-crack reinforcement
- have allowance for movement approximately every 15m and at abutments
- be installed to provide an even surface
- be grouted, as specified in the design.
- be protected until adequately cured and dried (permanent waterproofing should not be installed until the deck has fully dried).



7.1.7 Thermal insulation and vapour control

Also see: BRE Report 'Thermal insulation: avoiding risks' and BS 5250

Thermal insulation, vapour control and ventilation shall ensure satisfactory performance, and prevent the formation of condensation which could adversely affect the construction.

Insulation should be:

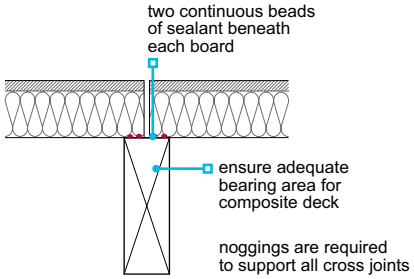
- bonded or mechanically fixed in accordance with the manufacturer's recommendations; where mechanically fixed, it should be installed using fixings of sufficient length to ensure adequate penetration into the supporting structure
- kept dry and installed in quantities which can be quickly covered if it rains (to aid bonding and to avoid trapping moisture).

Cold flat roofs are difficult to detail correctly but, where used, they should be in accordance with BS 5250 and have:

- an effective vapour control layer at ceiling level
- an unobstructed 50mm ventilation space above the insulation
- adequate cross ventilation (openings at both ends of each joist void).

Composite decks should:

- have two beads of sealant along each board joint at the foil underface (to maintain the integrity of the vapour control layer).



Insulation for inverted roofs should be:

- extruded polystyrene (XPS), extruded polystyrene with a cementitious surface or suitably assessed in accordance with Technical Requirement R3
- suitable for external use
- suitable for the weight of the ballast and able to withstand anticipated traffic
- protected by a geo-textile layer to prevent fines from reaching the membrane surface.

Vapour control layers should be provided to warm roofs, and:

- include at least one layer of bitumen roofing membrane (S2P3) below the insulation, fully bonded or mechanically fixed to the structural deck as appropriate, or a suitable self-adhesive or torch-on membrane.
- sealed at laps to the waterproofing, at the perimeter and at each penetration, e.g. at outlets and pipes (where the roof is a single-ply system, the vapour control is generally not sealed to the waterproofing).
- where a mechanically fixed system is used, the vapour control layer should consist of suitable polyethylene sheet sealed at all laps.

7.1.8 Waterproofing and surface treatments

Flat roofs, and balconies forming roofs, shall adequately resist the passage of water to the inside of the building. Issues to be taken into account include:

a) installation of waterproofing
b) waterproofing systems
c) surface treatments.

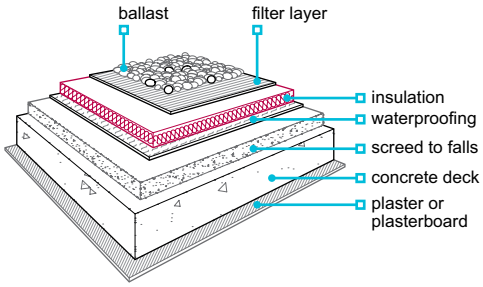
Installation of waterproofing

Prior to the waterproofing being installed:

- the structure and receiving surface should be checked and approved by the waterproofing contractor
- the manufacturer's recommendations for preparation, including priming upstands, roof outlets, etc. should be followed to achieve a satisfactory bond with the waterproofing
- the surface should be even and dry and nails should be punched below the surface
- the manufacturer's recommendations for conditioning, and unrolling in advance of laying, should be followed
- concrete and screed surfaces should be adequately dry.

Environmental conditions should be suitable for installing waterproofing. Issues to be taken into account include the following:

- Sheet membranes should not be installed or handled when the air temperature is 5°C or less (unless otherwise agreed with the manufacturer).
- Self-adhesive reinforced bitumen membranes should not be installed below 10°C, and the manufacturer's recommendations should be followed.
- Membranes should not be installed on damp or frosted surfaces or when any rain, sleet or snow is falling.



Waterproofing should be:

- installed in accordance with the design and the manufacturer's recommendations
- installed by a specialist roofing contractor approved by the manufacturer, where a proprietary system is used
- installed by the same contractor who installs the vapour control layer, insulation and surface finish
- checked by the contractor to ensure that the deck and insulation boards are waterproofed at the end of each day, and before inclement weather
- installed so that membrane laps near outlets do not impede drainage
- installed so that successive layers do not trap water.

Inverted roofs should:

- not be used for slopes greater than 10°
- be designed to support the loads, particularly from ballast needed to retain the insulation material
- be ballasted to the depth specified in the design
- be ballasted using paving slabs or minimum 19mm diameter rounded pebbles.

Waterproofing systems

Reinforced bitumen membrane

Reinforced bitumen membrane should be high performance and reinforced with polyester reinforcement, e.g. type 5U, 5B/180, 5B/250 to BS 8747 (type 5 reinforced bitumen membranes are colour-coded blue for identification).

Table 3: Reinforced bitumen membrane used in warm roof construction

Insulation material	First/preparatory layer	Second layer/underlay	Final layer/cap sheet
Rigid urethane foam (RUF) boards – polyurethane (PU) and polyisocyanurate (PIR).	Type 3G perforated layer (loose laid and lapped, to produce partial bonding).	S2P3	S5P5 with either integral mineral finish or separate solar protection.
		Elastomeric underlay achieving S2P3	Elastomeric capsheet achieving S2P3, mineral surfaced where exposed.
Compressed cork, rock fibre or glass fibre boards, cellular glass slabs, perlite boards or composite products.	S2P3 (fully bonded in accordance with BS 8217).	S2P3	S5P5 with either integral mineral finish or separate solar protection.
		Elastomeric underlay achieving S2P3	Elastomeric capsheet achieving S2P3, mineral surfaced where exposed.

Table 4: Reinforced bitumen membrane for an inverted warm roof

Deck material	First/preparatory layer	Second layer/underlay	Final layer/cap sheet
Concrete, or concrete with sand/cement screed.	Type 3G perforated layer (loose laid and lapped, to produce partial bonding).	S2P3	S5P5 with either integral mineral finish or separate solar protection.
		Elastomeric underlay achieving S2P3	Elastomeric capsheet achieving S2P3, mineral surfaced where exposed.

Torching onto insulation boards, except rockwool or perlite, is not acceptable.

Elastomeric (i.e. SBS polymer-modified) bitumen membranes offer increased extensibility and flexibility, especially at low temperatures, and can provide a longer service life.

Mastic asphalt

Mastic asphalt should be:

- to BS 6925, type 988 T25, 20mm thick on the flat and installed on black sheathing felt
- (for green roofs) 3 x 10mm layers on horizontal surfaces and 2 x 10mm layers on vertical surfaces, for green roofs.

Polymer modified asphalt should be assessed in accordance with Technical Requirement R3.

Thermoplastic single-ply membranes

Thermoplastic single-ply membranes, including materials such as PVC (polyvinyl chloride) and TPO (thermoplastic polyolefine) should be:

- either bonded to the insulation, mechanically fixed to the deck or loose-laid, and sealed and ballasted in accordance with the manufacturer's recommendations
- welded at laps using either hot air or a specific solvent
- assessed in accordance with Technical Requirement R3.

Surface treatments

Surface treatments should be in accordance with Table 5.

Table 5: Surface treatments for flat roofs

	Access for maintenance only – roofs up to 10°	Access roof, walkway or terrace deck
Reinforced bitumen membranes	■ Mineral surfaced capsheets (e.g. type S5P5). ■ Reflective stone chippings(1), bedded in a dressing compound. ■ A suitable thickness of washed, rounded 20-40mm shingle ballast laid loose.	■ Precast semi-porous concrete tiles bedded in bitumen or approved adhesive. ■ Precast concrete proprietary paving slabs on supports or sand/cement blinding(2). ■ Proprietary timber decking systems(3).
Mastic asphalt	■ Reflective stone chippings(1), bedded in a bitumen based compound. ■ A solar reflective paint approved by the MAC.	■ Precast semi-porous concrete tiles bedded in bitumen or approved adhesive. ■ Precast concrete proprietary paving slabs on supports or sand/cement blinding(2).
Thermoplastic single-ply membranes	■ Supplementary solar reflective coatings or other finishes not required. ■ Where laid loose, membranes can be ballasted with a suitable thickness of washed, rounded 20-40mm shingle installed on a non-woven polymeric protection layer.	■ Proprietary flexible, non-slip walkway sheets or tiles, compatible with the membrane product. ■ Precast concrete proprietary paving slabs on adjustable supports or suitable non-woven polymeric protection layer. ■ Proprietary timber decking systems with bearers set on an additional membrane or suitable non-woven polymeric protection layer.
Cold applied liquid roofing membranes	■ Products generally do not require supplementary solar reflective coatings or other finishes.	■ Proprietary surface treatments compatible with the membrane product. ■ Proprietary flexible, non-slip walkway tiles, compatible with the membrane product. ■ Precast concrete proprietary paving slabs on supports on a suitable non-woven polymeric protection layer. ■ Proprietary timber decking systems with bearers set on additional pads on a suitable non-woven polymeric protection layer.
Hot melt rubberised bitumen systems	■ Use in inverted/buried roof membrane applications or in roof garden/green roofs. ■ Must be protected with a substantial reinforced bitumen membrane protection sheet. ■ All upstands/details where the membrane becomes exposed need a protective membrane to be applied to prevent UV degradation.	

Notes

1 Loose surface finishes should be prevented from being removed by weather and discharged into gutters and drain pipes. Chippings should be a minimum of 12.5mm limestone or white spar, not pea gravel.

2 Cement/sand blinding should be installed on two layers of waterproof building paper or two layers of 1000 gauge polyethylene separating membrane. Slabs should be kept back 75mm at perimeters and a 25mm movement gap incorporated for every 9m² of paving.

3 Timber decking systems should only use compatible preservative treatments. The undersides of the bearers should have large, smooth contact areas, with no sharp edges or corners.

7.1.9 Green and proprietary roofs

Green roofs and proprietary roofing systems shall be suitable for their intended use.

Green roofs should:

- be clearly defined by the supplier as a complete system
- have supporting data to demonstrate compliance with relevant standards
- include waterproofing suitable for use in the green roof system.

Rainwater outlets should be accessible and have a visible inspection hatch.

Green roof systems that do not comply with the principles of this chapter should be assessed in accordance with Technical Requirement R3.

The complete green roof should be installed by a contractor trained and approved by the system supplier.

Waterproofing for green roofs should be either:

- reinforced bitumen membrane
- mastic asphalt
- single-ply membrane, or
- a liquid applied system.

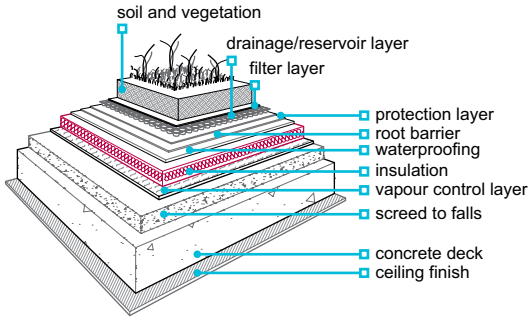
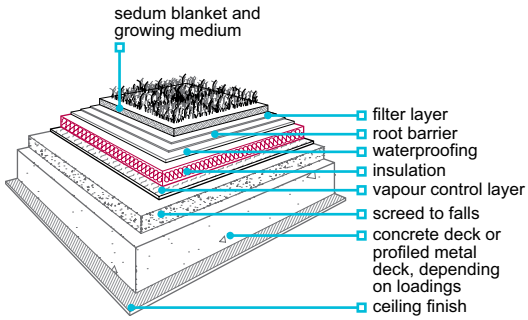
The system should be installed in accordance with the design and the membrane manufacturer's recommendations. Before covering:

- the membrane should be visually inspected and electronically tested for waterproofing integrity, faults rectified, and retested before further layers are placed: the results should be made available to NHBC
- any damage to the vapour control layer should be repaired, using a full width section of membrane.

Other issues that should be taken into account when installing green roofs include the:

- provision of root barriers
- height of upstands in relation to soil height and flashings
- protection, reservoir and filter layers
- moisture control of the soil.

Table 6: Principles for green roofs

	Intensive	Extensive
		
Features	■ Provides a normal garden environment. ■ Uses natural topsoil 150mm deep and 'normal' plants. ■ Requires regular 'intensive' maintenance, i.e. similar to a normal garden. ■ Requires protection of the waterproofing membrane from possible damage during maintenance of the garden, e.g. from weeding/planting.	■ Requires minimal maintenance, i.e. annual attention. ■ A sedum blanket contains the plants.
Structure	■ 20° maximum roof pitch, accounting for full weight of wet soil (generally supported by a concrete deck).	■ 45° maximum roof pitch deck (profiled metal decks may be an alternative to concrete, depending on loadings).
Drainage falls	■ 1:60min.	
Moisture control	■ Irrigation system may be required. ■ Can be designed to retain some water in order to maintain the vegetation and to reduce run off.	
Vapour control layer	■ Fully bonded polyester-reinforced RBM (S2P3), a suitable self-adhesive membrane or torch-on membrane.	
Insulation	■ Insulation material should have adequate compressive strength to withstand likely applied loads. Where the insulation is above the weatherproofing, only extruded polystyrene (XPS) should be used.	
Roots	■ A root resistant element, such as a copper foil or Preventol treatment, is required above the waterproofing membrane. Alternatively, an approved root resistant waterproofing membrane can be used.	
Protection and filter layers	■ A protection layer (or board) should be placed above the waterproofing membrane. ■ A filter layer should be placed above the reservoir layer.	■ In accordance with the manufacturer's recommendations.

7.1.10 Detailing of flat roofs

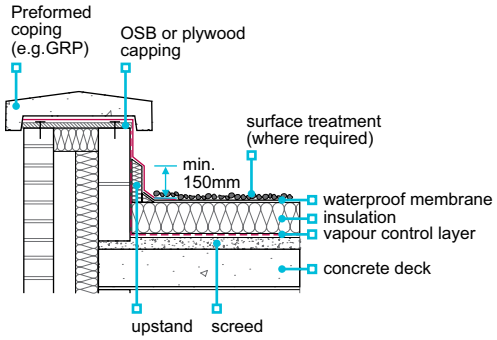
Flat roofs shall be detailed to ensure satisfactory performance.

The following illustrations are intended as a guide to demonstrate the general principles of flat roof detailing commonly used on warm flat roofs and balconies. Where indicated, the principles are applicable to other types of roof construction. Further information on specific waterproofing systems may be obtained from BS 6229 and BS 8217.

Concrete decks

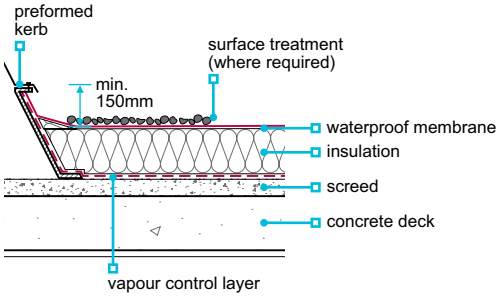
Upstands

Upstands may be fixed to the wall.
Upstands should be a minimum of 150mm high.
Similar details apply to inverted roofs with concrete decks.



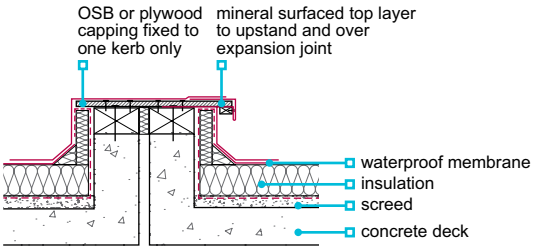
Skirting to rooflights or ventilator kerb

Similar details apply to inverted roofs.
Allow for thickness of ballast to achieve a minimum 150mm upstand.



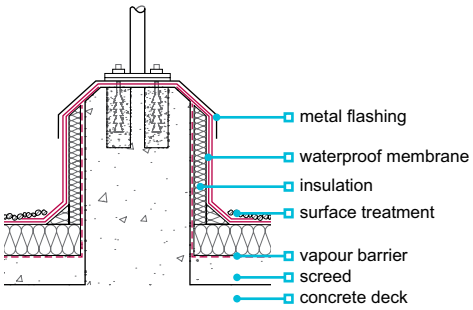
Twin-kerb expansion joint

Similar details apply to inverted roofs.



Handrail fixing

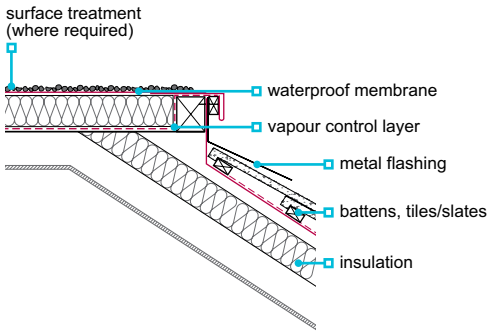
An upstand should be formed in concrete roofs.



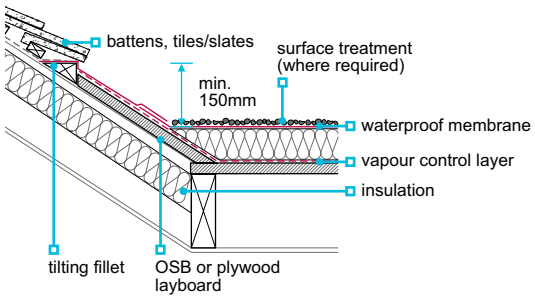
Timber decks

Mansard edge

Elements should be firmly fixed to prevent peelback in high winds.

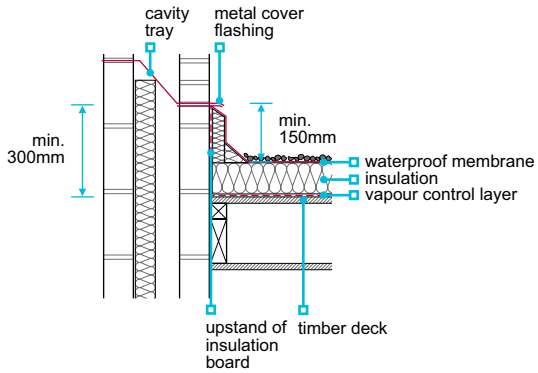


Pitched roof abutment



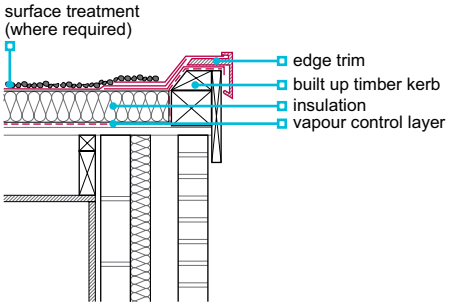
Independent skirting detail

Upstand should be kept separate from wall, and allow for movement. Upstand should be a minimum of 150mm high. Similar details apply to cold deck timber roofs.



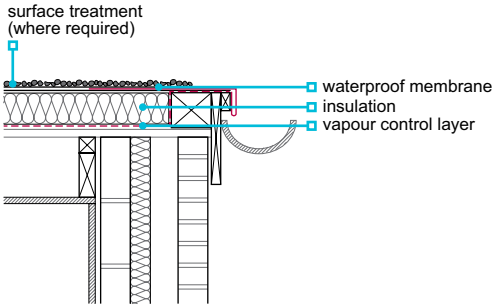
Verge detail

Similar details apply to inverted decks.



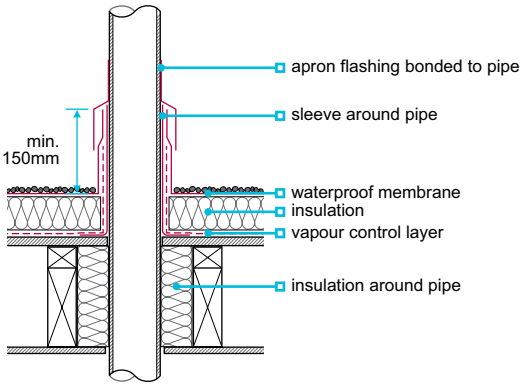
Welted drip to external gutter

Inverted timber decks should be detailed to avoid insulation being lifted by wind suction and an alternative detail used.



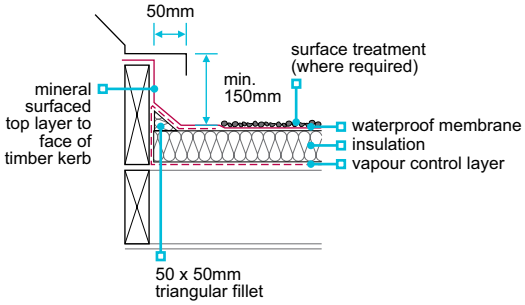
Pipe passing through roof

Vapour control layer should be bonded to the waterproofing. Detailing of upstand and flashing is similar for all roofs.



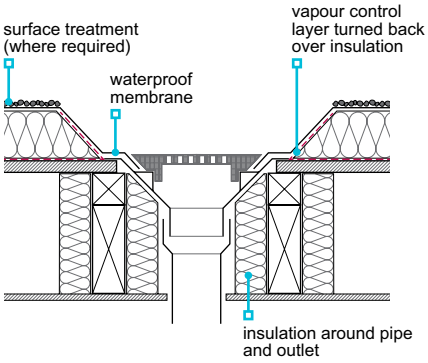
Upstand to ventilator or rooflight kerb

Similar details apply to cold and inverted roofs. Allow for the thickness of ballast in inverted roofs, to achieve upstand dimensions.



Rainwater outlet

The opening should be properly trimmed.
The outlet should be at the lowest point in roof.
Ensure that the outlet is fixed securely to decking to prevent displacement by thermal expansion of rainwater pipe.
Similar details apply to concrete roofs.

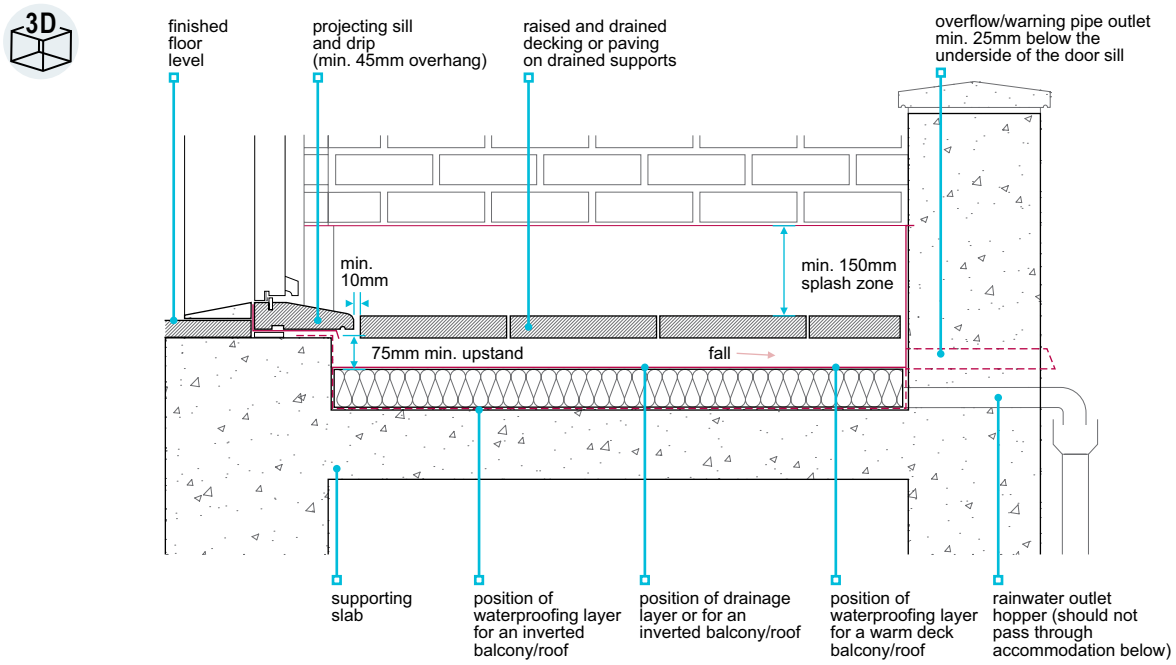


7.1.11 Accessible thresholds

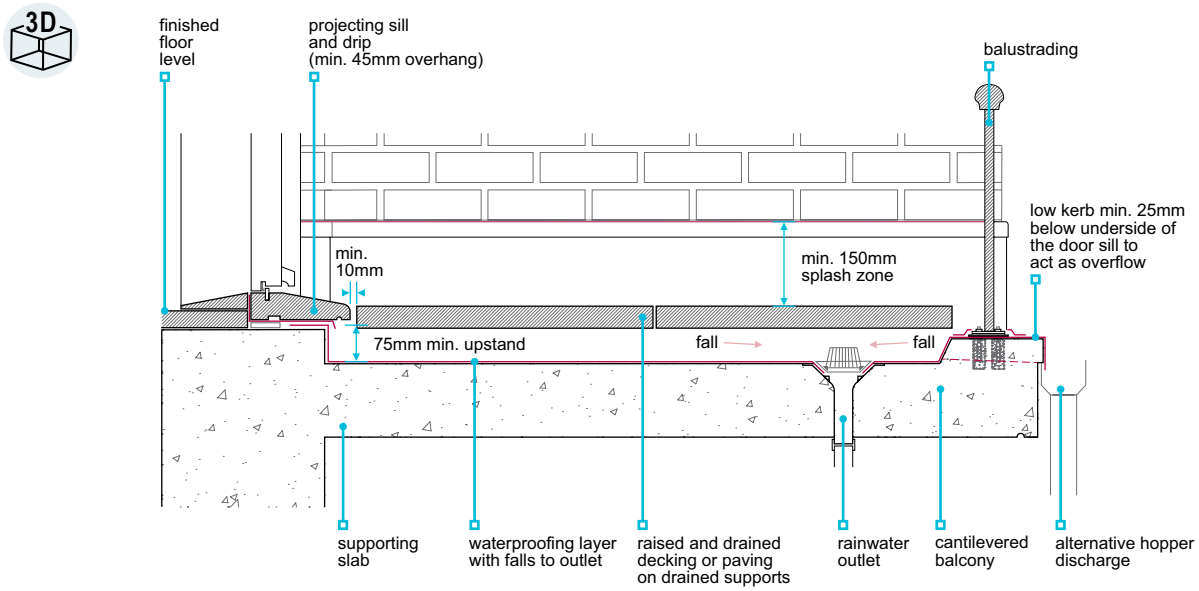
Accessible thresholds shall be protected by adequate weatherproofing and drainage.

Accessible thresholds should:

- be in accordance with the design – specific fire, thermal and acoustic precautions may be required
- have a maximum 15mm upstand (measured at the door position) at the door threshold; additional sloping transition elements, such as a small internal ramp and external sill, may be provided either side of the upstand; the maximum slope on ramps and sills should be 15 degrees
- have a minimum 45mm projecting sill to shed rainwater away from the interface with the waterproofing layer
- have a 75mm minimum balcony upstand below the underside of the projecting sill, measured from the balcony drainage layer.



Note
The drainage layer is not necessarily the waterproofing layer (i.e. the top of the insulation of an inverted roof should be considered as the drainage layer).



Waterproofing layers should:

- prevent ponding and associated stagnant water
- generally fall a minimum of 1:80 away from the building to the rainwater outlet(s)
- be subject to specific third-party assessment where falls are zero degrees
- be designed to ensure that where falls are towards or parallel to the building, blockage of the outlet(s) cannot cause flooding to the building
- be fully protected from direct trafficking
- be capable of withstanding point loads from supports to decking or paving
- be UV resistant or fully protected from daylight.

Drainage arrangements should be effective and have a suitable overflow. The building should not flood where an outlet or downpipe is blocked. This can be achieved by using:

- at least one outlet and an overflow with the capacity of the outlet
- at least one outlet chute and hopper (sized to serve both the discharge and overflow capacities)
- two outlets connected to independent downpipes, or
- setting the balcony kerb a minimum of 25mm below the door threshold.

Outlets beneath decking or paving should be clearly identifiable and accessible for maintenance.

To ensure adequate drainage:

- gaps should be provided between decking and paving at balcony perimeters
- minimum 10mm gaps should be provided between individual units of decking or paving and the threshold sill, perimeter walls and kerbs
- spacers and supports which raise decking or paving should not obstruct the flow of rainwater to outlet(s).

A splash barrier should be provided:

- to ensure water does not reach any part of the wall that could be adversely affected by the presence of moisture
- to a minimum of 150mm above the decking or paving
- using an impervious wall finish or cladding, or extending the waterproofing layer to form an upstand with cover flashings and cavity trays.

7.1.12 Drainage

Flat roofs and balconies shall have adequate and effective rainwater drainage to a suitable outfall. Issues to be taken into account include:

a) falls **b) outlets.**

The principles for drainage given in Chapter 7.2 ‘Pitched roofs’ are applicable to flat roofs and balconies.

Rainwater disposal from roofs and balconies 6m^2 or less in area should be considered. Where run-off may cause damage or staining to a façade, or damage to landscaping, then rainwater gutters and downpipes should be provided. The cumulative effect of water discharging from multiple balconies in vertical alignment should be taken into account.

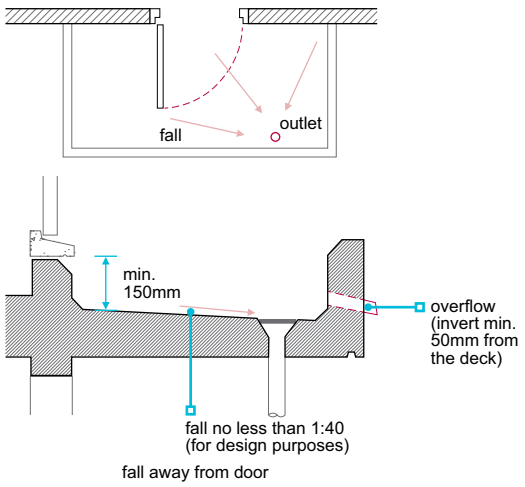
Open slatted balcony decking should drain away from the home.

Falls

Flat roofs and balconies should:

- be designed with a fall no shallower than 1:40 to ensure a finished fall of no less than 1:80, unless a detailed analysis which includes overall and local deflection is used as justification
- have a minimum finished fall of 1:80 (green roofs 1:60), unless it has a metal sheet covering
- account for deflection in the structural design where falls are achieved using screeds (particularly on large roofs).

Where decking or paving is installed above the waterproofing and is less than 150mm below the sill, it should be of a type and design that prevents a build-up of standing water.



Where tapered insulation is used:

- drainage should be designed by the insulation manufacturer, with falls of no less than 1:60
- construction should comply with the design and manufacturer's recommendations
- the sequence of installation should ensure that boards are waterproofed and the roof sealed at the end of each day, or before the arrival of inclement weather
- it should be installed directly onto the vapour control layer, with the primary waterproofing above
- cross falls should be formed with mitred joints
- successive roof layers should be installed with a minimum of delay, to avoid trapping water during construction.

Metal sheet roofs

Flat roofs with metal sheet roof coverings should be designed with a fall of no less than 1:30 to ensure a finished fall of no less than 1:60.

Concrete roofs

Concrete roofs can be finished with sand/cement screed topping set to achieve the falls. Screed finishes should be:

- free from ridges and indentations
- finished with a wooden float to provide a smooth, even surface for the vapour control layer and waterproof finish
- installed by specialist contractors where a lightweight finish is used, and have a topping of 1:6 (cement:sand), 13mm thick
- to the minimum thickness in Table 7 where a cement/sand screed, 1:4 (cement:sand) is used
- suitably dry and primed to receive the waterproofing system.

Table 7: Minimum screed thicknesses

Location of screed	Nominal thickness (mm)
Bonded monolithically to in-situ or precast concrete	40 (25 minimum.)
Unbonded (on separating layer)	70 (50 minimum.)

Timber roofs

Firring pieces should be:

- used to form falls, unless the design specifies a sloping joist or ceiling
- of the sizes given in Table 8 where installed across the joists.

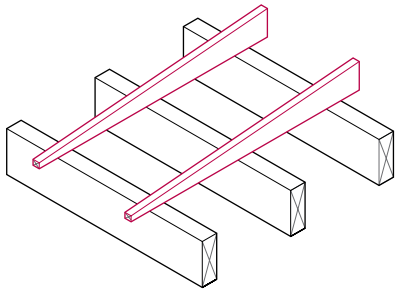


Table 8: Size of firring pieces used to form cross falls

Joist centres (mm)	Minimum width (mm)	Minimum depth (mm)
400 or 450	38	38
600	38	50

Rainwater outlets

Rainwater outlets should:

- be of the size and number required to deal with the expected rainfall intensity in accordance with BS EN 12056-3
- be recessed to facilitate the free flow of water
- be accessible for maintenance.

Where a flat roof or balcony has an upstand on all sides, drainage should consist of either two outlets or one outlet plus an overflow. The overflow should be:

- provided through parapet walls or perimeter upstands
- sized and positioned to prevent water from entering the building
- of higher capacity than the combined capacity of the other outlet(s).

7.1.13 Guarding to balconies

Also see: Chapter 6.1

Balconies, and flat roofs to which persons have regular access other than for maintenance, shall be adequately guarded to minimise the risk of falling. Issues to be taken into account include:

a) guarding
b) stability of guarding
c) strength and movement of masonry balcony walls
d) durability and fixing of balustrading and guard rails
e) access for maintenance.

Guarding

Guarding should:

- not be easily climbed
- be to an adequate height
- be toughened glass, laminated glass or glass blocks where glazed balustrading is used
- not be fixed through the waterproofing unless suitable precautions are taken.

Stability of guarding

Guarding, including parapet walls, and balustrading used as guarding, should be designed in accordance with BS EN 1991-1-1 to resist horizontal loading and as required by the building regulations. Particular care is needed when the design incorporates balustrading fixed to parapet walls to ensure stability and prevent overturning. End fixings or returns may be needed to ensure stability.

In balcony walls (especially long balconies) the structural stability should be checked, as the DPC at the base of the wall can create a slip plane that can seriously limit the ability of the wall to resist horizontal forces. In such cases, it may be necessary to incorporate a ring beam or other support to ensure stability.

Strength and movement of masonry balcony walls

Masonry balcony walls should be built in accordance with Chapter 6.1 ‘External masonry walls’. In particular:

- walls should incorporate strengthening as required by the design
- movement joints should be provided in accordance with the design
- copings should be firmly fixed.

Durability and fixing of balustrading and guard rails

Balustrading and guard rails should be of adequate durability and fixed securely. Also see Clause 7.1.4(a).

Access for maintenance

Provision should be made for safe future access to flat roofs for the purposes of maintenance.

Pitched roofs

CHAPTER 7.2

This chapter gives guidance on meeting the Technical Requirements for pitched roofs, including:

- **coverings**
- **vertical tiling**
- **fixings**
- **ventilation**
- **weatherproofing.**

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7.2.1 Compliance

Also see: Chapter 2.1

Pitched roof structures and coverings shall comply with the Technical Requirements.

Pitched roofs that comply with the guidance in this chapter will generally be acceptable.

Roofs with a tile or slate covering should be in accordance with BS 5534.

7.2.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- The layout of trusses and associated items.
- Details of mono-pitch, lean-to roofs and roof intersections (i.e. hips and valleys).
- Details of girder trusses, multiple trusses and diminishing trusses, including how they are to be fixed together and supported on truss shoes, layboards or similar.
- Details of bracing requirements.
- Details of supports for equipment in the roof space.
- The type and position of vapour control layers.
- Details of restraint/holding-down strapping, including coatings and fixings.
- The position and thickness of insulation.
- The means of providing eaves ventilation.
- Details of firestopping at separating wall and boxed eaves.
- Details of coverings and fixings, including number and type.
- Details of flashing details at abutments, chimneys, etc.
- Details of trimming around chimneys, access hatches, etc.

For trusses, the design should be provided to the manufacturer in accordance with PD 6693-1, which includes:

- usage, height and location of building, referencing any unusual wind conditions
- rafter profile, referencing camber where required
- spacing, span and pitches
- method of support and position of supports
- type and weight of coverings, including sarking, insulation and ceiling materials
- eaves overhang and other eaves details
- size and approximate position of water tanks or other equipment to be supported
- positions and dimensions of hatches, chimneys and other openings
- type of preservative treatment, where required
- special timber sizes, where required to match existing construction.

7.2.3 Design of pitched roofs

Also see: TRADA Eurocode 5 span tables (3rd edition) and BS 8103-3

The sizing and spacing of members shall ensure structural stability and provide restraint to the structure without undue movement or distortion. Issues to be taken into account include:

a) trussed rafter roofs **b) traditional cut roofs.**

The design of pitched roofs should:

- have dead and imposed loads calculated in accordance with BS EN 1991-1-1, BS EN 1991-1-3 and BS EN 1991-1-4
- be in accordance with PD 6693-1, and Technical Requirement R5, where appropriate
- be appropriate for the location, accounting for exposure and wind uplift
- ensure that the structure is coherent and that all forces are resolved
- ensure stability with the complete structure, including the connections and compatibility with the supporting structure and adjacent elements
- where trussed rafters and a cut roof are combined, the designer should provide details of the complete roof (particular care is needed in such circumstances).

Roofs should be designed by an engineer in accordance with Technical Requirement R5 where:

- the roof is not a basic pitched roof
- hips, valleys or other special features are included in a trussed rafter roof
- the spans, sizes, spacing or strength classes of the timber are outside the scope of authoritative tables
- trussed rafters support traditional cut roof members, or
- it is a proprietary system (designs supplied by manufacturers will generally be acceptable).

Structural timber should be of a suitable grade and specified according to the strength classes in BS EN 338, e.g. C16, C24 or TR26. When using the BS 4978 grading rules:

- the timber specification should be in accordance with BS EN 1912, or the timber species and strength class identified
- the timber should be marked accordingly.

Trussed rafter roofs

Trussed rafters should be:

- installed in accordance with the design, and the structure or spacing should not be altered without prior consent from the designer
- fixed to the wall in accordance with the design (e.g. using double skew nailing or truss clips)
- vertical and suitably located (where necessary, temporary bracing should be used to maintain spacing and to keep trusses vertical)
- evenly spaced at maximum 600mm centres.

Where the maximum 600mm spacing cannot be achieved, e.g. to accommodate hatch openings or chimneys, spacing may be increased to a maximum of twice the nominal spacing, provided that the spacing X is less than, or equal to, 2A-B where:

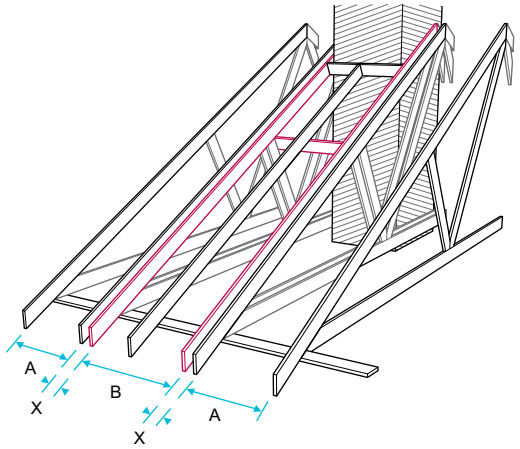
- X = distance between centres of trussed trimmed rafters and the adjacent trussed rafter
- A = design spacing of trussed rafters
- B = nominal width of opening.

Where multiple and reinforcing timbers to simple or multiple trussed rafters are used, they should be:

- designed to be permanently fastened together
- either fixed together during manufacture, or fully detailed drawings and specifications showing the fixing method should be supplied.

Hipped roofs constructed with trussed rafters typically require a series of diminishing mono-pitched trusses supported by a girder truss.

The bearing of mono-pitched trusses into shoes should be in accordance with Table 1, unless designed by an engineer in accordance with Technical Requirement R5.



trussed trimmed rafters

Table 1: Bearing length of mono-pitched trusses into shoes

Span	Minimum bearing length	Minimum thickness of trussed rafter
Less than 4m	50mm	35mm
4m or more	75mm	35mm

Ceiling finishes should be fixed according to the spacing of the support members and the thickness of the sheet. Plasterboard should be fixed as follows:

- 9.5mm plasterboard should be fixed at a maximum support spacing of 450mm
- 12.5-15mm plasterboard should be fixed at a maximum support spacing of 600mm
- Additional members will generally be required to support coverings and finishes where trusses are spaced further apart.

Where the width of a gable ladder exceeds that of the trussed rafter centres, noggings should be used to reduce the span of the roofing tile battens.

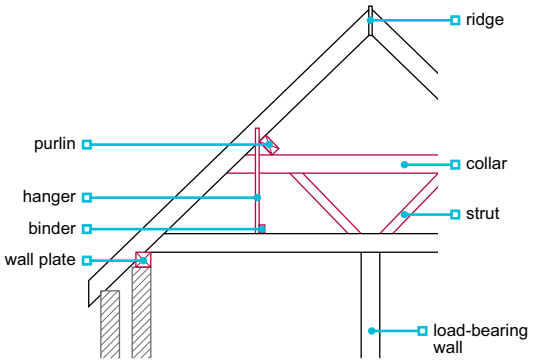
Traditional cut roofs

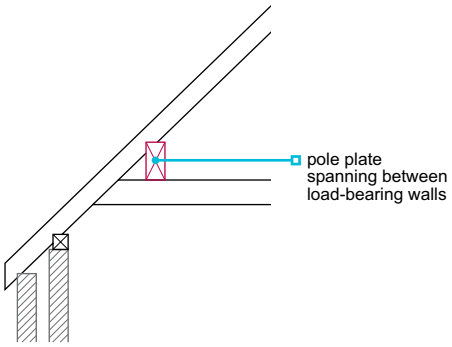
For traditional cut roofs:

- the design should specify the details of each structural member and the method of fixing or jointing
- the roof should be in accordance with the design and members accurately located
- members should be fully supported and tied together where necessary, particularly where the roof is not a simple triangle
- temporary support to long span members should be used until framing is complete
- purlins and binders should be built in where necessary
- framing should be completed before coverings are installed.

Table 2: Basic timber members

Member	Notes
Valley rafter	Provides support for loads from both sections of the roof and should: ■ be larger than ordinary rafters to take the additional load ■ provide full bearing for the splay cut of jack rafters ■ be provided with intermediate support where required.
Hip rafter	Provides spacing and fixing for jack rafters and should: ■ have a deeper section than the other rafters to take the top cut of the jack rafters. Purlins should be mitred at hips and lip cut to accept the bottom of the hip rafter.
Ceiling joist or ties	Provides support for the rafters and should: ■ stop the walls and roof spreading outwards ■ provide support to the ceiling finish and walkways, etc.
Ridge	Provides fixings and spacing for the tops of the rafters.
Purlin	Provides support to long span rafters to prevent deflection and increase stiffness.
Struts	Provides support to purlins to prevent deflection and to transfer roof loads to the load-bearing structure below.
Collar	Ties the roof together at purlin level.
Ceiling binders and hangers	Provides support to long span ceiling joists.
Pole plates	Similar to purlins, but used where ceiling joists are above wall plate level.

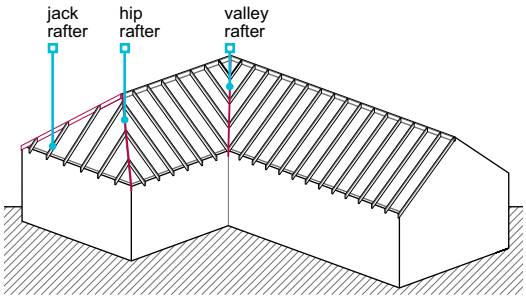




Generally sizes should be as Table 3, unless designed by an engineer in accordance with Technical Requirement R5.

Table 3: Typical sizes for timber members

Member	Minimum size
Struts	100mm x 50mm
Valleys	32mm thick
Ridges and hips	Rafter cut + 25mm



7.2.4 Protection of trusses

Also see: International Truss Plate Association Technical Handbook

Trusses shall be protected from damage.

Where the trusses or timber members are damaged, they should be rejected and not repaired. To avoid distortion and to prevent damage, trusses should be:

- protected against weather to prevent the corrosion of truss plates and the deterioration of the timber
- adequately ventilated during storage
- stored clear of the ground
- stored vertically and propped
- stored with level bearers under the joints
- carried upright (fasteners can loosen when carried flat).

7.2.5 Durability

Timber shall be of suitable durability.

The following timber members should be naturally durable or treated in accordance with Chapter 3.3 'Timber Preservation (natural solid timber)':

- Porch posts.
- Tiling battens.
- Soffits.
- Bargeboard.
- Fascias and other trim.

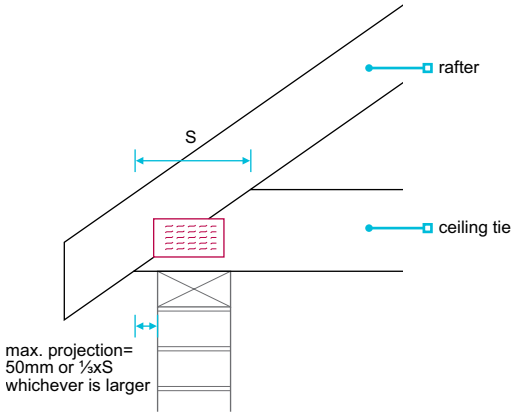
Where the roof is to include a fully supported weatherproofing membrane, the following timber components should either be naturally durable or suitably treated:

- Rafters.
- Purlins.
- Ceiling joists.
- Bracing.
- Sarking.
- Wall plates.
- Battens for fixing vertical cladding.

7.2.6 Wall plates

Wall plates and the roof structure shall be bedded and fixed to distribute and transmit loads, and to prevent uplift.

Trussed rafter roofs and traditional cut roofs should be supported on timber wall plates. Trussed rafters should only be supported at the junction between the ceiling tie and rafter, unless specifically designed otherwise, e.g. as a cantilever.



Wall plates should be:

- bedded to line and level
- fixed using nails or straps
- a minimum of 3m or extend over at least three joists, rafters or trusses
- joined using half-lapped joints, including at corners
- 38 x 100mm or in accordance with local practice.

Fixings used to connect the roof structure to the wall plate should be specified according to the roof construction and exposure of the site.

Where trussed rafter roofs are not subject to uplift, a minimum of two 4.5mm x 100mm galvanized round wire nails, skew nailed, one on each side of the trussed rafter, or truss clips (fixed in accordance with the manufacturer's instructions) are acceptable.

Where the roof is required to resist uplift, skew nailing is unlikely to provide sufficient strength, and appropriate metal straps should be used. Holding-down straps should be:

- provided according to the geographical location and construction type
- provided where the self-weight of the roof is insufficient against uplift
- provided in accordance with the design
- a minimum cross section of 30mm x 2.5mm and spaced at a maximum of 2m centres (galvanised steel straps are generally acceptable)
- fixed to the wall, or turned into a bed joint.

Fixings for straps should be:

- in accordance with the design, and the lowest fixing should be within 150mm of the bottom of the vertical strap
- of a material or finish which is compatible with the straps
- where into masonry, hardened 4mm x 75mm nails or 50mm long No 12 wood screws (into suitable plugs).

7.2.7 Joints and connections

Joints and connections shall be designed to ensure structural stability without undue movement or distortion.

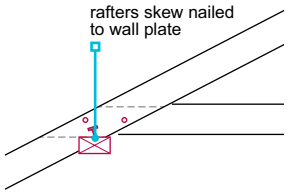
Members should:

- be accurately cut to fit tightly
- not be damaged or split.

The following joints should be used at the main connections of traditional cut roof members:

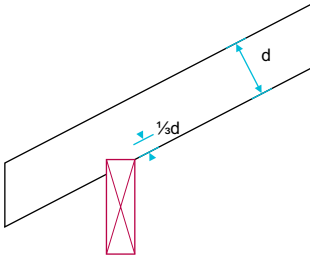
Rafters to ceiling joists using a nailed lapped joint

The rafter should be birdsmouthed and skew nailed to the wall plate.



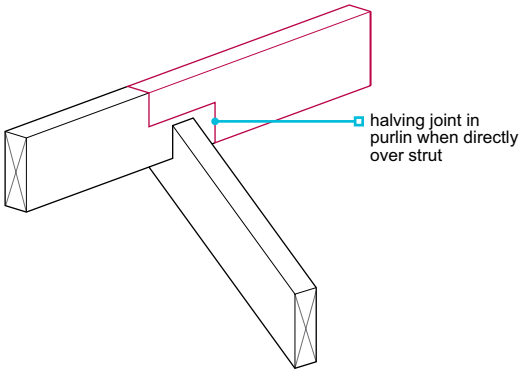
Rafter to purlin

A birdsmouth joint should be used generally the purlin is fixed vertically.



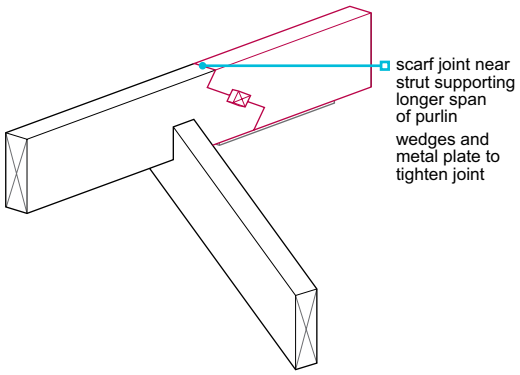
Purlin connections

Support should be provided directly under the joint or a scarf joint used. Scarf joints should be made near to a strut so that the joint supports the longer span.



Scarf joint

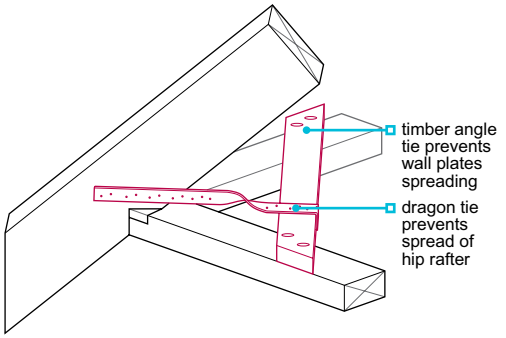
Used to support the long span of the purlin.

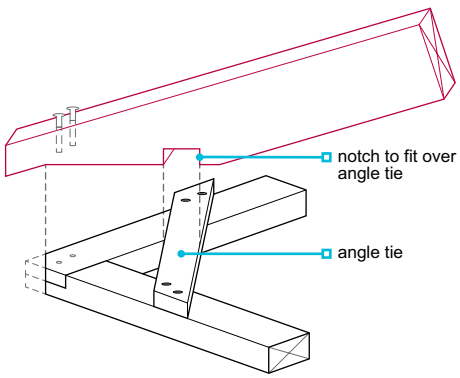


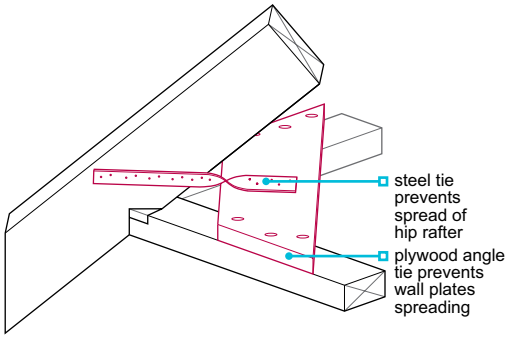
Hipped roof joints

Angle ties should be used at the corners of hipped roofs to prevent the wall plates from spreading.

Where hip rafters are heavily loaded, e.g. carrying purlins, they should be jointed using dragon ties, or similar, to prevent the hip rafter spreading.







7.2.8 Restraint

Also see: Chapter 6.1

Adequate restraint shall be provided to support the structure, distribute roof loads and prevent wind uplift. Strapping shall be of adequate strength and durability, and fixed using appropriate fixings.

Restraint straps, or a restraining form of gable ladder, should be used where required to provide stability to walls, and be installed in accordance with the design.

Lateral restraint straps should be located:

- for homes up to and including three storeys (two storeys in Scotland), at a maximum spacing of 2m
- for homes four storeys or over, fixed at a maximum spacing of 1.25m.

Lateral restraint straps should be fixed to the roof structure by either:

- fixing to solid noggings using a minimum of four 50mm x 4mm steel screws or four 75mm x 4mm (8SWG) round nails, with one fixing in the third rafter (Figure 1), or
- fixing to longitudinal bracing members using eight 25mm x 4mm steel screws evenly distributed along the length of the strap (Figure 2). Alternatively, 100mm x 25mm timber members, fixed over four trusses and nailed in accordance with Clause 7.2.9 can be used where the position of the strap does not coincide with a longitudinal binder.

Figure 1

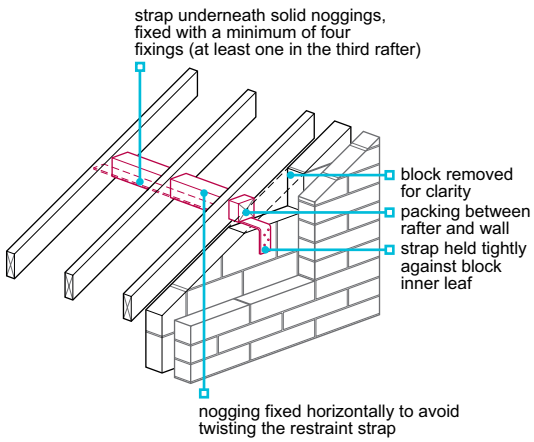
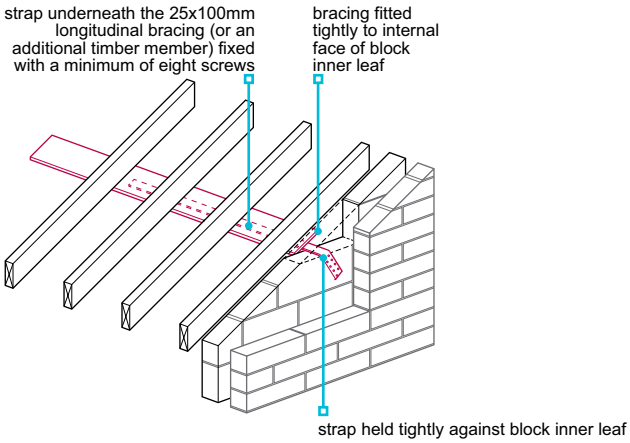


Figure 2



Lateral restraint straps should be:

- ordered and supplied according to the design, i.e. the correct length and number of bends and twists
- provided at rafter level on gable walls, where the home is of masonry construction (larger or separating walls may require restraint at ceiling level)
- protected against corrosion in accordance with BS EN 845-1 Clause 6.1.11 Table 4 (sherardised straps or fixings are not acceptable in Northern Ireland and the Isle of Man)
- of sufficient length to be fixed to a minimum of three trusses
- a minimum size of 30mm x 5mm and have a minimum anchorage downturn to 100mm (or proprietary straps)
- fixed with the downturn on a substantial piece of blockwork, preferably fitted over the centre of an uncut block
- in accordance with BS EN 1995-1-1, where the home is of timber frame construction.

In framed roofs, as an alternative, purlins and pole plates can be used to provide restraint where the timber abuts a gable construction. Where purlins are used to provide restraint, the maximum permissible spacing is 2m unless the design shows otherwise.

Gable ladders can be used to provide restraint to the external wall where:

- there is blocking between the last trussed rafter and the inner leaf (maximum 2m spacing)
- the soffit board is cut carefully and then fixed securely to restrain the outer leaf.

Proprietary straps should be:

- In accordance with Technical Requirement R3
- Installed in accordance with manufacturer's recommendations.

7.2.9 Bracing for trussed rafter roofs

Also see: BS EN 1995-1-1 and PD 6693-1

Trussed rafters shall be suitably braced to support applied loads and self-weight without undue movement.

For the purposes of this chapter, the guidance and use of standard trussed rafter bracing does not apply to homes on or near exposed sites, e.g. flat coastal fringes, fens, airfields and moorland. In such cases, bracing should be designed by an engineer in accordance with Technical Requirement R5.

Standard trussed rafter bracing, in accordance with Table 4, is generally acceptable, where the home:

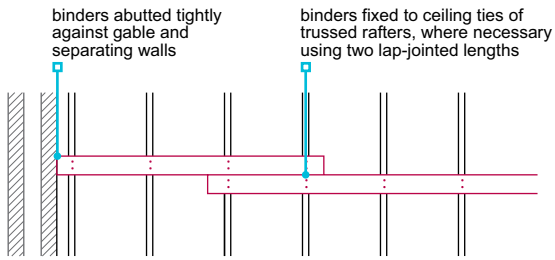
- has a rectangular roof (including hip ends) and is either a duo-pitched or a mono-pitch structure
- is not taller than 8.4m (to the underside of the ceiling tie)
- is braced in accordance with this chapter
- is braced according to the conditions of the site and in accordance with the design
- does not have trusses which span more than 12m
- has trusses which are only supported at each end
- does not have unsupported masonry spanning more than 9m (between buttressing walls, piers or chimneys)
- has a ceiling of plasterboard directly under each truss (where there is no plasterboard, i.e. garages, additional diagonal ceiling bracing and longitudinal binder bracing at each ceiling node point is required.

Table 4: Location, height and span for standard bracing conditions

	Type	Duo-pitch						Mono-pitch								
	Maximum pitch	35°			30°			35°			30°			25°		
	Storeys	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Maximum span (m)	England and Wales	10.6	9.1	8.5	12	11.5	10.2	5.6	4.5	4.3	6.6	5.8	5.1	8.1	7.2	6.4
	Scotland	9.8	7.7	7.2	11.6	10.0	8.8	4.9	4.2	3.6	5.8	5.0	4.4	7.3	6.4	5.6
	Areas north or west of Ullapool	8.6	7.2	6.0	10.6	8.7	7.5	4.3	3.6	3.0	5.1	4.4	3.7	6.5	5.6	4.5
	Northern Ireland and the Isle of Man	9.8	7.7	7.2	11.6	10.0	8.8	4.9	4.2	3.6	5.8	5.0	4.4	7.3	6.4	5.6
	Areas north-east of Londonderry	8.6	7.2	6.0	10.6	8.7	7.5	4.3	3.6	3.0	5.1	4.4	3.7	6.5	5.6	4.5

Roof bracing should be:

- in accordance with this chapter or PD6693-1
- in accordance with the design and not altered without prior approval from the designer
- appropriate for the site (where the site is in an exposed location, the design should be checked for additional requirements, and the bracing completed as specified suitably fixed to the wall plate)
- completed before the roof covering is laid
- provided using a minimum timber size of 100mm x 25mm (3mm tolerance)
- nailed twice to each rafter it crosses; fixings should be 3.35mm x 65mm (10 gauge) galvanized round wire nails
- where braces and binders are not continuous, they should be lap jointed and nailed to a minimum of two trusses.



When bracing pitched roofs:

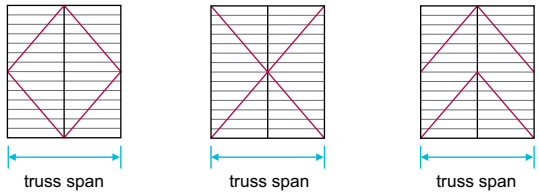
- diagonal and longitudinal bracing should be provided at rafter level (this may be omitted where rigid sarking boards are used, e.g. chipboard, plywood or OSB, which are fixed to each trussed rafter with 3mm x 50mm galvanised round wire nails at 200mm spacing)
- diagonal and chevron bracing should pass across each rafter in the roof, however, small gaps, such as two trussed rafters between sets of bracing, or one trussed rafter adjacent to gable or separating walls, is permitted in the middle of an otherwise fully braced roof
- longitudinal bracing members should extend the full length of the roof, tightly abut gable and party walls and permit diagonal bracing to pass (they may be lap-jointed providing the overlap is nailed to a minimum of two trussed rafters)
- there should be a minimum of four diagonal rafter braces in each roof; in narrow fronted roofs and mono-pitched roofs, where the braces cross, the intersection detail (below) should be used.

Diagonal rafter bracing

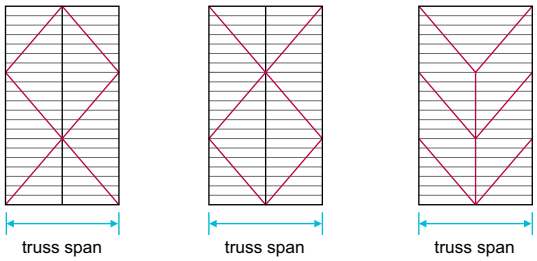
Applicable to all trussed rafter roofs unless rigid sarking, such as timber boarding or plywood, is used.

Diagonal rafter bracing should be approximately 45° to the rafters on plan.

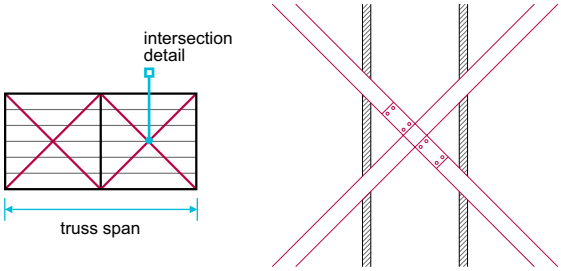
Bracing for roofs that are approximately square



Bracing for larger roofs



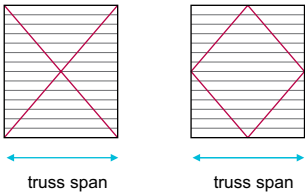
Bracing for roofs less than 6.6m wide on detached or staggered/stepped buildings



Intersection details should be formed by:

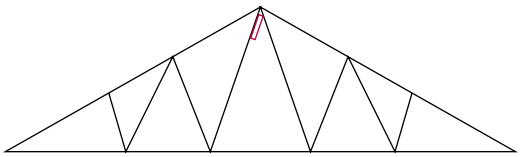
- 22mm x 97mm x 600mm timber splice plate
- nailing, using a minimum of four 35mm x 65mm galvanised round wire nails to each side of the intersection, with nails driven through bracing and clenched over.

Bracing for mono-pitch trusses



Longitudinal bracing member at ridge node point

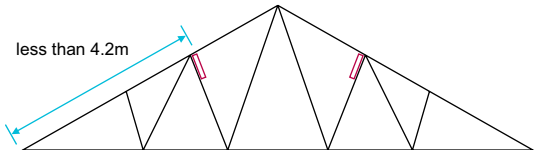
Applicable to all trussed rafter roofs. Not necessary where rigid sarking, such as OSB, timber boarding or plywood sheeting, is used.



Longitudinal bracing member at rafter node point

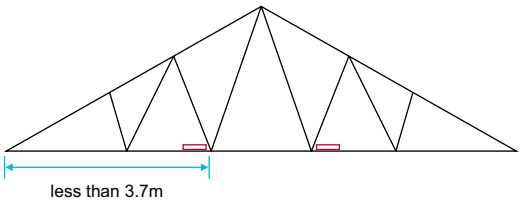
Applicable to all rafter node points. Not necessary where:

- spacing between braced nodes is less than 4.2m, or
- rigid sarking, such as OSB, timber boarding or plywood sheeting, is used.



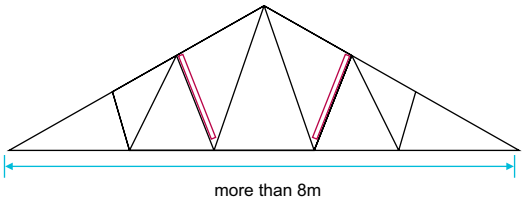
Longitudinal binders at ceiling node points

Applicable to all ceiling node points. Not necessary where the spacing between braced nodes is less than 3.7m.



Chevron bracing between webs

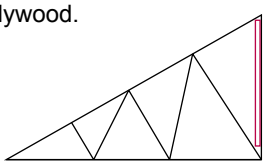
Where the span exceeds 8m. For mono-pitch roofs of any span and duo-pitch roofs over 11m span, bracing should be designed by an engineer in accordance with Technical Requirement R5.
It should be approximately 45° to the web members.



Diagonal bracing to end vertical of mono-pitch trusses

Applicable where the truss is not restrained by:

- a masonry wall, or
- cladding, i.e. plywood.



7.2.10 Strutting for attic trusses and cut roofs that form a floor

Strutting to attic trusses shall be provided to support the applied loads and self-weight without undue movement or distortion.

Strutting should be provided:

- in accordance with the design
- where the span between the node points which form the width of the floor of the attic truss exceeds 2.5m
- where the span between the supports to a floor within a cut roof exceeds 2.5m
- using herringbone (38mm x 38mm timber) or solid strutting (a minimum of 0.75x the depth of the floor and a minimum of 38mm thick).

Table 5: Provision of strutting

Span of floor	Rows of strutting
Under 2.5m	None required
2.5m-4.5m	One (at centre of span)
Over 4.5m	Two (at equal spacing)

7.2.11 Support for equipment

Permanent equipment in roof voids shall be adequately supported.

Where equipment (e.g. water tanks and MVHR fan units) is located in the roof void, the structure should be designed in accordance with PD 6693-1 and the truss manufacturer's recommendations, to support the additional load.

7.2.12 Access

Also see: Clause 7.2.15

Roof voids shall be provided with suitable access.

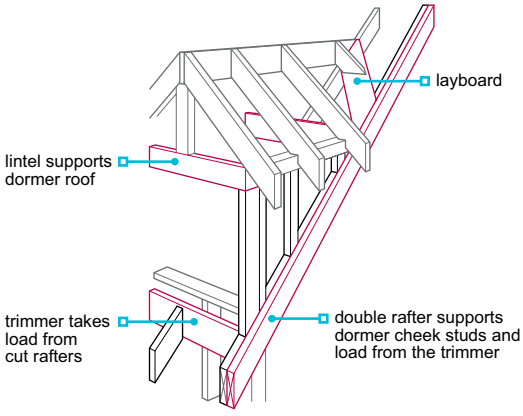
Access should:

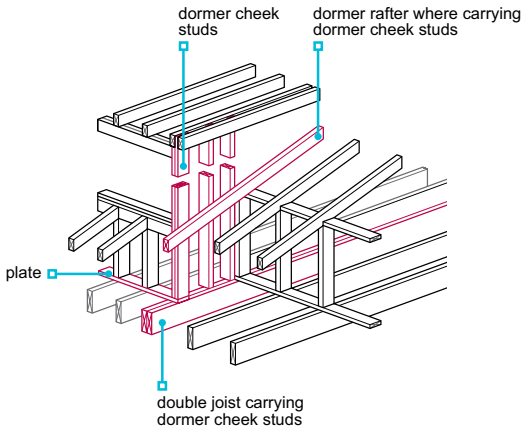
- be provided to the main roof space and voids which contain cisterns and tanks etc. though it is not required to roof spaces which contain only water pipes
- permit the removal of permanent equipment (e.g. heating and ventilation plant) located in the roof space
- have a minimum opening width of 520mm in each direction
- not be located directly over stairs or in other hazardous locations
- include securely fixed boarded walkways between the opening and the cistern or other permanent equipment; boarding should be securely fixed without compressing the insulation; at each piece of permanent equipment or cistern, a minimum 1m^2 platform should be provided to facilitate maintenance.

Access hatches should be in accordance with Clause 7.2.15. Where an access hatch is required to provide fire resistance, the fire-resistance period should be supported by test evidence.

7.2.13 Dormer construction

Dormer constructions shall be of adequate structural stability.





For dormer roofs:

- construction should be in accordance with the design
- cheek studs should be supported by either a double rafter or a double floor joist
- where cheek frames do not extend to floor level, two fixed rafters should be used to provide the necessary support
- trimming members should be large enough to support additional loads from the main roof members, dormer framing and cladding
- a suitable lintel should be provided over the opening
- lintels should be structurally independent from the window frame.

7.2.14 Underlay and sarking

Underlay and sarking shall be provided to resist the passage of moisture.

Underlay and sarking should:

- be in accordance with the manufacturer's recommendations
- take account of the type and fixing of the roof covering
- be used in accordance with relevant assessments.

In areas of severe exposure, a rigid sarking with underlay is recommended.

Table 6: Acceptable materials for use as underlay and sarking

Material	Standard
Tongued and grooved or square-edged boarding	BS 1297
Exterior grade plywood	BS EN 636 service class 3
Chipboard (type P5)	BS EN 312
OSB (type OSB3)	BS EN 300
Felt	BS EN 13707
Proprietary products	Technical Requirement R3

Underlay should:

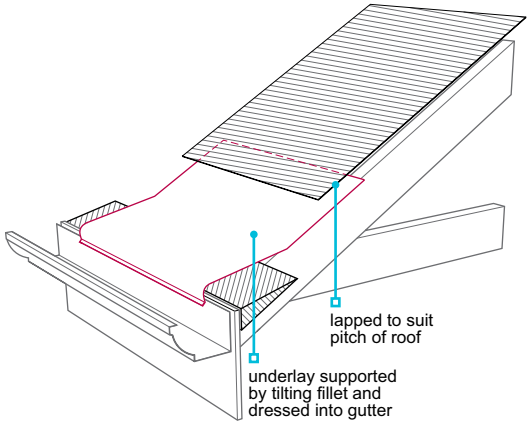
- be provided to all tiled roofs
- where it is above rigid sarking (fully supported), be of low vapour resistance, i.e. less than 0.25MNs/g (where the underlay is highly vapour-resistant, increased ventilation to the roof space or between the underlay and sarking should be provided as necessary)
- where exposed at eaves level, be UV resistant or of type 5U felt or a proprietary eaves guard used (type 1F may be used for the remainder of the roof)
- be supported by a continuous fillet or proprietary eaves support tray to prevent sagging (which can form a water trap)
- be securely fixed
- at vertical laps, be fixed only over rafters, and at horizontal laps, be held in place by battens
- be cut neatly, fit tightly and not be torn, i.e. where pipes project through the underlay
- be dressed into the gutter and cut neatly to fit tightly around service penetrations
- where traditional mortar pointing is used to bed ridge tiles, extend over the ridge
- continue over hips to form a 150mm minimum lap parallel with the hip rafter
- at abutments, be supported and turned up by a minimum of 100mm
- be draped to allow water to drain behind the tiling battens.

Table 7: Horizontal laps for unsupported underlay

Pitch	Minimum horizontal laps
Less than 15°	225mm
15-34°	150mm
35° and above	100mm

At valleys:

- the main roof underlay should be cut to the valley batten line
- a strip of underlay should be laid under the main roof underlay and held down by the valley battens (where used).



7.2.15 Ventilation, vapour control and insulation

Roofs shall have adequate precautions against condensation and cold. Issues to be taken into account include:

a) ventilation, vapour control and insulation
b) dormer construction
c) pipework.

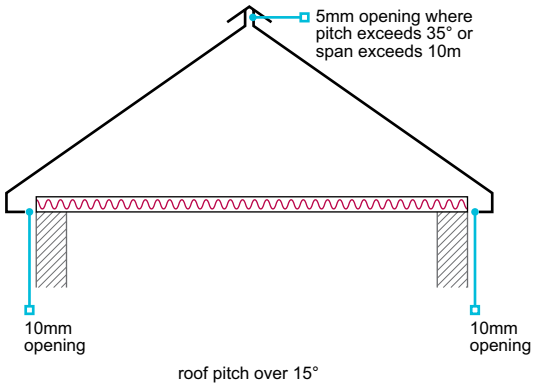
Ventilation, vapour control and insulation

To provide adequate ventilation and to avoid condensation in roof voids, pitched roofs that have insulation at ceiling level should be ventilated to the outside air:

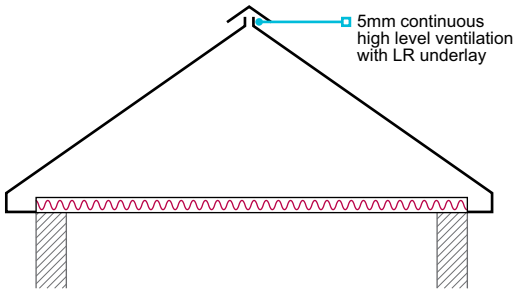
- Ventilation openings should prevent the entry of birds, etc. (fabrications with 3mm-10mm openings are acceptable).
- Ventilation paths should remain clear, i.e. not blocked by insulation or the structure.
- A spacer in the eaves should be used to allow insulation to be installed over and beyond the wall plate to minimise the cold bridge without blocking the ventilation path (the spacer should be of sufficient length to maintain ventilation above the insulation).
- Where proprietary eaves ventilators are used, they should be fixed in accordance with the manufacturer's instructions.

Ridge or high-level ventilation equivalent to a continuous opening of 5mm should be provided at the highest point of each roof slope in accordance with BS 5250 in the following situations:

- Unventilated cold roofs have insulation placed over a horizontal ceiling and a vapour-permeable underlay (type LR) is used.
- Vapour permeable underlays are used on sloping roofs with areas covered by non-permeable materials (e.g. flat roofed areas of mansard roofs).
- The roof is covered with high water vapour resistant (type HR) underlay and the pitch exceeds 35° or the span exceeds 10m (this is in addition to eaves ventilation).

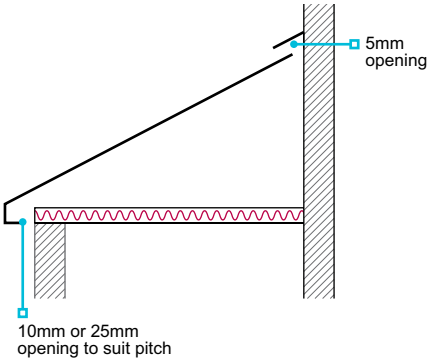


roof pitch over 15°

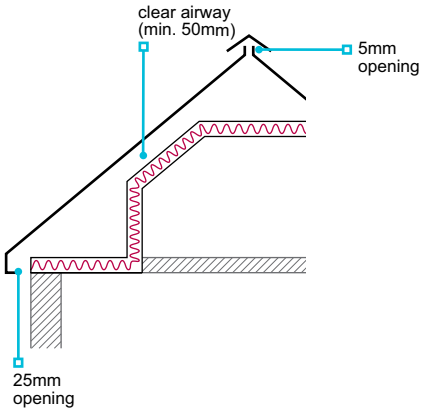


Where high water vapour-resistant (type HR) underlay (e.g. types 1F/5U felts) is used, eaves ventilation should be provided on opposite sides of the roof to permit cross ventilation, and:

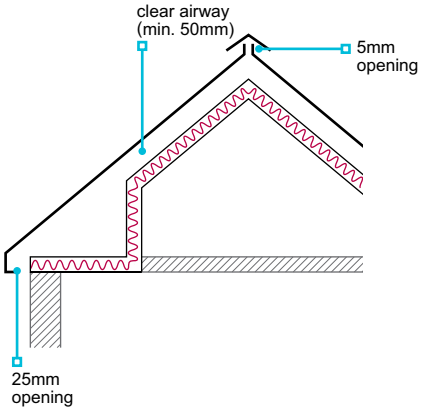
- where the roof pitch is 15°or more, ventilation equivalent to a 10mm slot running the full length of the eaves should be provided
- where the ceiling follows the slope of a roof, regardless of pitch, or where a cold roof has a pitch less than 15°, ventilation equivalent to a 25mm slot running the full length of the eaves should be provided (a nominal clearance of 50mm should be maintained between the insulation and the roof underlay)
- for mono-pitched roofs, cross ventilation should be in accordance with BS 5250 and have ventilation equivalent of a continuous high-level 5mm slot, in addition to eaves ventilation.



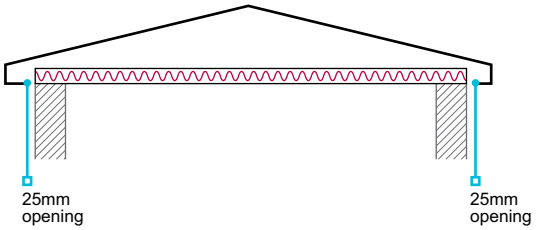
mono-pitched roof



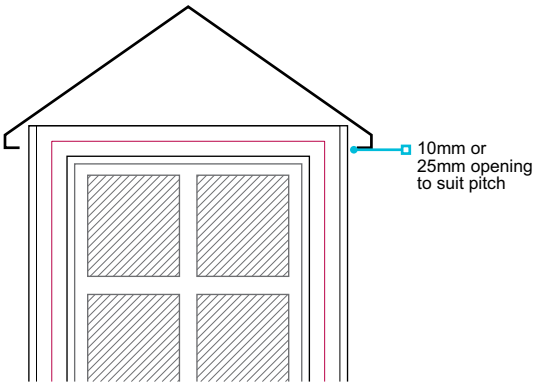
room-in-roof (partially sloping ceiling)



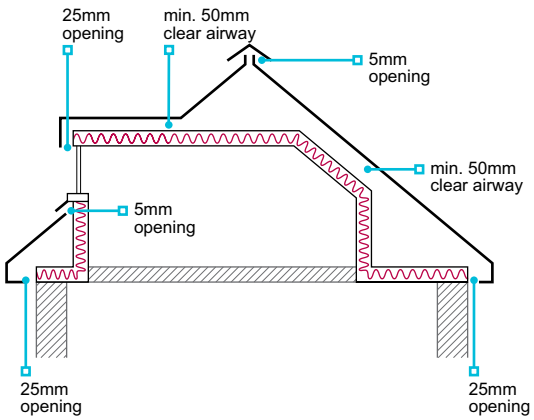
room-in-roof (completely sloping ceiling)



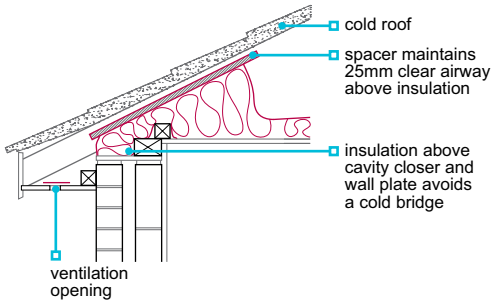
roof pitch below 15°



pitched roof dormer



room in roof (flat roof dormer)



To reduce moist air entering the roof space:

- gaps should be sealed where services pass through the ceiling
- where used, downlighters should be specified and sealed to limit air leakage.

Vapour control layers should be provided in accordance with the design, and where required should be:

- placed on the warm side of insulation
- used in roof constructions where the ceiling board is fixed to the rafters.

Where the ceiling below a cold pitched roof includes a vapour control layer, the design should ensure adequate ventilation is provided to the habitable areas to prevent condensation problems in the home.

Access hatches to cold roof voids should have:

- an air leakage rate not more than 1 M^3/h at a pressure of 2 Pa when tested to BS EN 13141-1, or
- a push-up cover with a minimum weight of 5.5 kg and compress a closed cell seal or ‘o-ring’ between the cover and frame (clamps may also be required to ensure that the cover compresses the seal).

The thermal performance of the access hatch should contribute to the overall thermal performance of the ceiling or wall in which the hatch is located, and avoid cold bridging.

Proprietary hatches should be fitted and sealed to the surrounding construction in accordance with the manufacturer's instructions.

Insulation should be of sufficient thickness to meet the requirements of Building Regulations, and laid over the whole loft and wall plate.

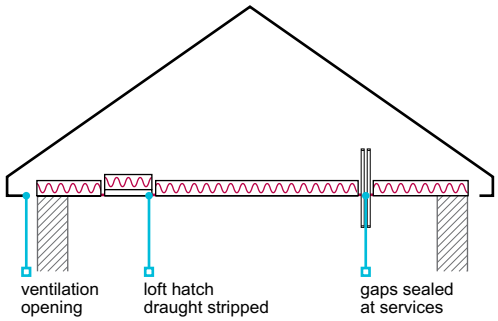


Table 8: Suitable materials for roof insulation

Material	Standard
Mineral fibre mats	BS EN 13162
Blown mineral fibre	BS 5803-2
Blown cellulose fibre	BS 5803-3
Proprietary products	Technical Requirement R3

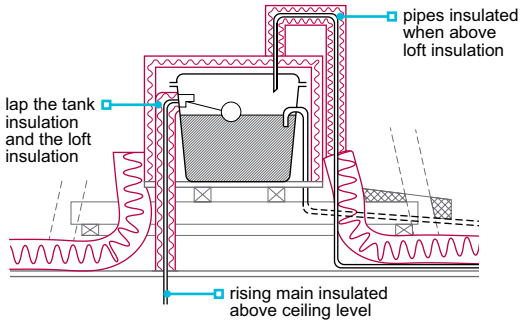
Dormer construction

Ventilation to dormers should be provided from eaves to eaves or from eaves to ridge.

Pipework

To reduce the risk of freezing or condensation forming on pipework, the following precautions should be taken:

- Where possible, water pipes should be below the main roof insulation.
- Water pipes should be insulated in accordance with Chapter 8.1 'Internal services'.
- Roof insulation should be placed above and around water tanks, but not below them.
- 'Cold rising' pipework above ceiling level should be insulated, even where it is below the main roof insulation.



In England and Wales, account should be taken of Accredited Construction Details.

7.2.16 Firestopping and cavity barriers

Also see: Chapter 6.8

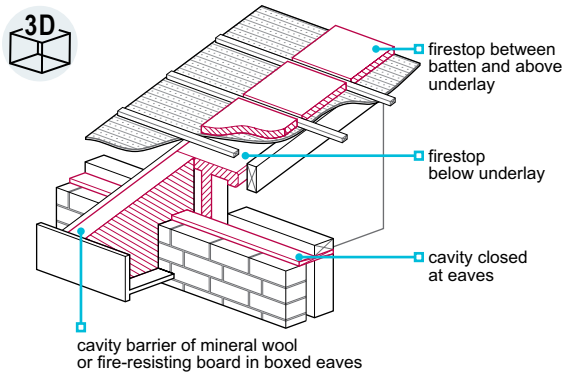
Pitched roofs shall be constructed to provide adequate fire resistance and separation.

Firestopping should be provided in accordance with building regulations, including:

- at the junctions between a separating or compartment wall and a roof
- at the junctions between cavities
- above separating walls
- within the boxed eaves at separating walls.

When providing firestopping:

- gaps between compartments should be sealed
- separating walls should stop approximately 25mm below the top of adjacent roof trusses, and a soft fire-resistant packing, such as mineral wool, should be used to allow for movement in roof timbers and prevent 'hogging' of the tiles
- a cavity barrier of fire-resisting board or a wire reinforced mineral wool blanket (50mm minimum) nailed to the rafter and carefully cut to fully seal the boxed eaves should be installed (ordinary mineral wool quilt is acceptable as firestopping above separating walls)
- a minimum 30min fire separation should be provided between the home and an integral garage.



Combustible material, such as roof timbers and sarking felt, should be kept away from heat sources.

7.2.17 Battens

Battens and counter battens shall be adequately sized and spaced to support the roof covering.

Battens and counter battens should be:

- in accordance with BS 5534, accompanied by a delivery note and marked with the supplier, origin, grade and size
- preservative treated
- where cut ends are in contact with mortar, treated with preservative
- cut square, butt jointed over rafters and nailed to each rafter they span
- fixed by skew driven nails on each side of the joint.

Counter battens should be fixed to the rafters and not only to sarking boards.

Battens should be:

- a minimum of 1.2m long and span a minimum of three rafters
- set out in straight lines parallel to the ridge and to the gauge required for the tile or slate (the lap should not be decreased as this would reduce weathertightness)
- set out so that the tiles project a minimum of 50mm over the gutter
- fixed through counter battens to rafters
- where on rigid sarking boards, supported on counter battens
- at verges, tile battens should finish 25mm-50mm from the face of the protecting undercloak
- sized in accordance with the roof covering manufacturer's recommendations, but not less than shown in Table 9.

Table 9: Suitable batten sizes

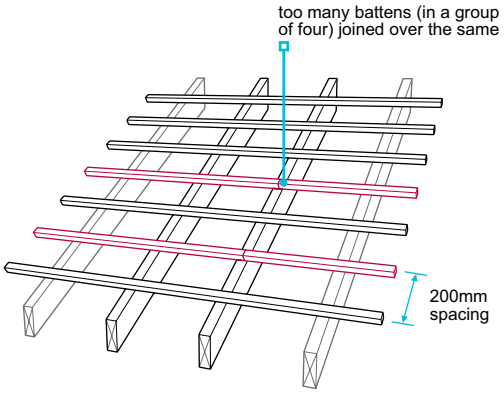
		450mm span	600mm span
Double lap slates	Natural: sized or random	25mm x 50mm	25mm x 50mm
	Fibre cement or concrete	25mm x 38mm	25mm x 50mm
Clay/concrete tiles	Double lap	25mm x 38mm	25mm x 38mm
	Single lap	25mm x 38mm	25mm x 50mm

Notes

1 Actual size should be within +/3mm of the nominal size).

Battens should be set out to avoid joints occurring over the same rafter. Where batten spacing is:

- more than 200mm, no more than one batten in any group of four should be joined over any one truss or rafter
- 200mm or less, no more than three joints should be made over any 12 consecutive battens.



Batten fixings should be:

- cut or wire nails in accordance with BS 5534
- a minimum of 3.35mm x 65mm long (10 gauge) and a minimum of 30mm longer than the batten thickness
- ring shank nails where specified (where the maximum basic wind speed is over 26m/s (National Annex Figure NA.1 of BS EN 1991-1-4), galvanized smooth round nails are not acceptable and ring shank nails should be used)
- hot dip galvanised steel or aluminium, when used in coastal areas
- in accordance with manufacturer's guidance where mechanical nail guns are used.

7.2.18 Roof coverings

Roof coverings shall be of a suitable quality and durability to protect the building from weather.

When covering a pitched roof:

- coverings should be in accordance with the design and established building practices
- recovered materials may be used where prior approval by NHBC has been granted (independent certification of suitability may be required).

Table 10: Standards relevant to roof coverings

Material	Standard
Clay tiles and fittings	BS EN 1304
Concrete tiles and fittings	BS EN 490 and BS EN 491
Dry fixed systems	BS 8612
Natural slates	BS EN 12326
Fibre cement slates and fittings	BS EN 492
Natural stone	Established practices
Lead sheet roofing	BS 6915
Rolled lead sheet	BS EN 12588
Thatch	Standards set by the Thatching Advisory Services or other appropriate authority, in accordance with Technical Requirement R3
Shingles should be of western red cedar	Grade 1 to the Canadian Standards Association
Sheet metal roofing, including lead, copper and zinc	Technical Requirement R3
Proprietary roofs, roof lights and coverings	Technical Requirement R3
Other roof coverings	CP 143

Where slates and concrete or clay tiles are designated AA to BS 476-3, they can be used without limitation on pitched roofs.

Table 11: Acceptable characteristics for natural slates

Characteristics	Grade (to BS EN 12326)
Water absorption less than 0.6%	A1
Thermal cycle	T1
Carbonate content less than 20%	S1

7.2.19 Fixing tiles and slates

Also see: BS 5534

Coverings shall be suitably fixed to protect the building from weather. Issues to be taken into account include:

a) eaves, ridge and hip tiles
b) verges
c) mortar
d) vertical tiling and slating.

Careful setting out will improve the finished appearance of the roof, help avoid problems such as unequal overhangs, and reduce excessive tile cutting at abutments, chimneys and similar obstructions.

When installing coverings:

- clay tiles that do not meet the dimensional and geometric requirements given in BS EN 1304 should not be laid at pitches less than 40°
- joints between tiles and slates should be slightly open, which provides some flexibility in setting out and should help to avoid tile cutting (single lap interlocking tiles have a tolerance of approximately 3mm at the joint)
- double tiles, tile-and-a-half or half tiles can be used when available from the manufacturer (to avoid the use of small sections of cut tiles). Alternatively, where the tile manufacturer provides guidance, small sections of single lap tile can be bonded to full tiles
- the bottom edges of double-lapped slate and plain tile roofs should be finished with an under-eaves course.

Table 12: Pitch, gauge and lap

Type or tile	Gauge	Minimum headlap	Minimum permissible pitch (°)
Plain (double lap)	Maximum 1/3 length lap	65mm generally for clay tiles 75mm in severe exposure conditions	35 (clay) 35 (plain concrete)
Concrete (single lap interlocking)	Comply with the manufacturer's recommendations	75mm or to the manufacturer's recommendations	30[2]
Slates (double lap)	Maximum 1/3 length lap	54mm[1] minimum, increased with lower pitch and severe exposure conditions	20 subject to headlap

Notes

1 For pitches greater than 45° in sheltered and moderate exposure zones only.

2 For pitches below 30°, evidence shall be provided as to suitable performance.

When fixing coverings to a pitched roof:

- the fixing schedule should be produced by the tile manufacturer; fixings for single and double lap tiles should be in accordance with BS 5534 and BS EN 1994-1-4 (evidence of calculations in compliance with Technical Requirements R3 and R5 may be required)
- coverings should be fixed in accordance with the design and the manufacturer's recommendations
- slates and tiles should be fixed using clout or slate nails (these should be either silicon bronze, aluminium to BS 1202-3 or copper to BS 1202-2).
- galvanized steel nails should not be used for slates and tiles (but are acceptable for fixing battens or underlay)
- fixings should be a minimum of 38mm long, and penetrate a minimum of 15mm into battens
- tile clips should be of plastic, aluminium or stainless steel
- slates should be fully nailed over the whole roof, and nailed twice where centre nailed.

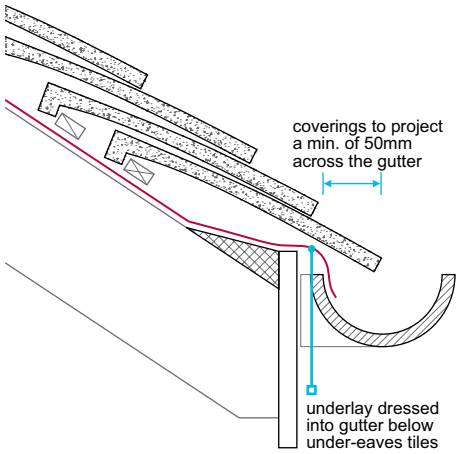
Eaves, ridge and hip tiles

At eaves:

- tiles should project a minimum of 50mm across the gutter
- when using slates or plain tiles, an under-eaves course should be used
- the height of the facia should maintain the tile pitch, in accordance with the tile manufacturer's recommendations.

Where ridge tiles are mortar bedded:

- the underlay should extend over the ridge.

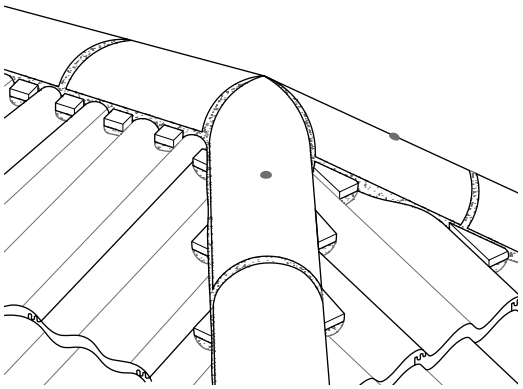


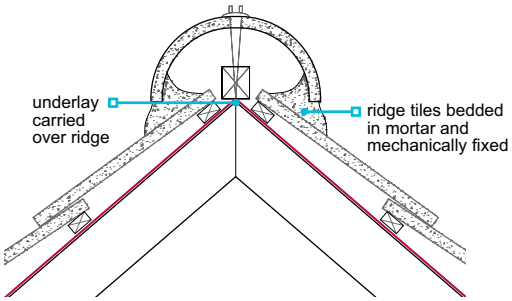
At hips:

- underlay should continue to form a 150mm minimum lap parallel with the hip rafter
- where wet bedded tiles are used, they should be supported at the base by a galvanized hip iron and project to the centre line of the gutter.

Ridge and hip tiles should be mechanically fixed with self-sealing non-ferrous fixings into timber battens, and have a nominal joint thickness of 10mm where wet bedded. Wet bedded 'baby' hip/ridge tiles to low level roofs, such as those over porches and ground floor bay windows, do not require mechanical fixing, unless recommended by the manufacturer.

Proprietary dry fixed systems should be in accordance with BS 8612.



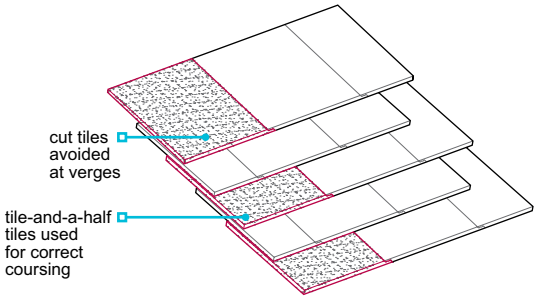


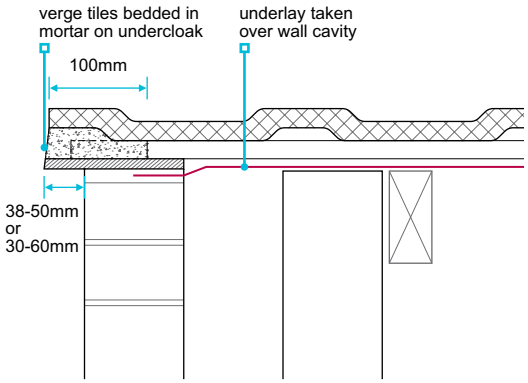
Verges

Unless a proprietary dry verge system or cloaked verge is used, tiles should be bedded into a 100mm wide bed of mortar on an undercloak of cement-based board, plain tile or slate. Plain tiles should not be used as an undercloak below 30°pitch or on a bargeboard.

Undercloak should be:

- fixed in accordance with manufacturer's recommendations
- installed to a true line
- installed at the correct level to ensure that the line of the tiling is maintained where it passes over the wall, and not tilt inwards
- bedded on roofing mortar and struck off flush with the external surface of the wall (alternatively, a suitable exterior grade bedding sealant should be used in accordance with the manufacturer's recommendations)
- securely nailed to a true line where a bargeboard is used.





Where verge tiles and slates are wet bedded, pointing should be completed as soon as possible using the same mix.

Verge clips should be in full contact with the tile to resist uplift, nailed twice to battens and sized to ensure that they are in direct contact with the top surface of the verge tile.

Where plain tiles and slates are used at the verge:

- they should project 38-50mm beyond the gable wall or bargeboard
- cut plain tiles are not acceptable, and purpose-made plain tile-and-a-half tiles should be used
- natural slate verges should be formed with full slates and either slate-and-a-half or half slates that are a minimum of 150mm wide.

Where interlocking tiles are used at the verge:

- they should project 30-60mm beyond the gable wall or bargeboard
- small sections (less than a half tile width) of cut interlocking tiles should not be used.

Mortar

When bedding tiles or slates in mortar:

- the mortar should be 1:3 cement:sand with plasticiser
- the mortar should be a mix based on sharp sand with soft sand added to achieve workability; the proportion of sharp sand should not be less than one third of the total sand content (proprietary mixes may be accepted by NHBC where they are shown to have similar strength, durability and workability)
- pointing should be completed as soon as possible using the same mix.
- tiles should be wetted on their contact surface, and surface water allowed to drain away before fixing
- concealed or decorative dentil tiles should be fully bedded into joints in excess of 25mm thick.

Vertical tiling and slating

When fixing vertical tiling and slating:

- a suitable moisture barrier should be used
- where the wall structure is solid brickwork or blockwork, the moisture barrier should be underfelt or equivalent
- where the supporting structure is of timber construction, the moisture barrier should be used with a breather membrane
- batten sizes should be in accordance with this chapter
- every tile or slate should be nailed twice and the bottom edges should be finished with an under-course tile
- at internal or external angles, purpose-made corner tiles or soakers should be used to form a weathertight joint
- where pitched roofs abut tiled walls, a stepped flashing should be specified and turned in behind the tiles
- at dormer cheeks, the tiles or slates should be specified to be cut close to the slope of the roof and over a flashing fixed to the side of the dormer.

7.2.20 Weathering details

Also see: Chapter 6.8

Weatherproofing shall be provided at abutments, flat roof intersections, changes in slopes and projections to resist the passage of moisture to the inside of the building. Issues to be taken into account include:

a) abutments
b) flat roof intersection or changes in slope
c) projections through the roof
d) copings.

Flashing details should be appropriate for the roof and the type of roof covering used, in accordance with BS 5534. Where flashings come into contact with metal, they should be formed using non-ferrous material.

Table 13: Suitable materials for flashings

Material	Standard	Additional information
Aluminium and alloys	BS EN 515	0.6-0.9mm thick, and protected from contact with mortar by a coating of bituminous paint
Copper	BS EN 1172	Flashings, soakers and saddles should be: ■ fully annealed ■ 0.55mm thick (0.7mm thick is suitable for gutters)
Rolled lead sheet	BS EN 12588	Flashings, gutter linings etc. should: ■ be a minimum of code 4, and soakers a minimum of code 3 ■ sections should not exceed 1.5m in length
Zinc alloy	BS EN 988	Should be a minimum of 0.6mm thick
Proprietary products	Technical Requirement R3	Should be securely fixed in accordance with the manufacturer's recommendations

Abutments

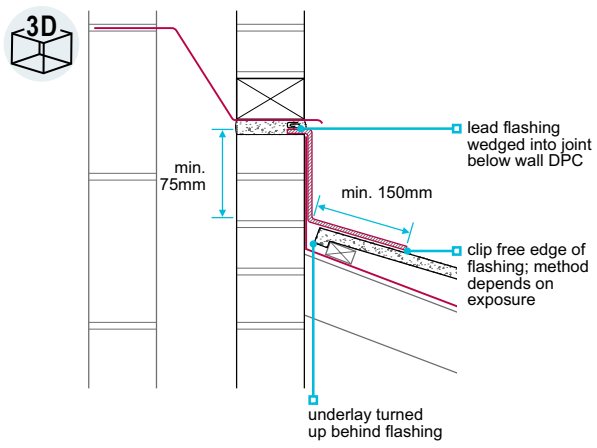
At abutments:

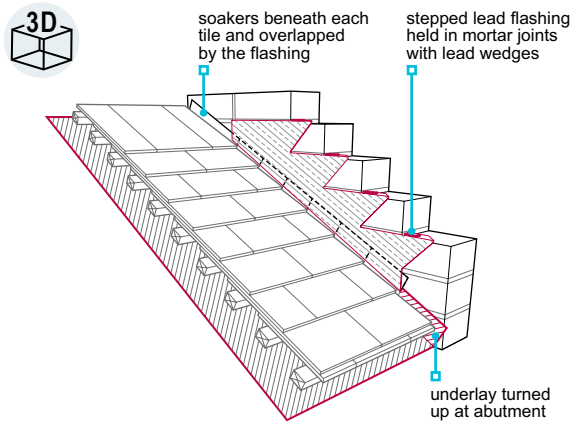
- flashings, soakers and gutters should be provided as necessary
- lead flashings should have a minimum lap of 100mm
- flashings should be tucked 25mm into a brick joint and wedged in place at not more than 450mm centres, or a minimum of one per step for stepped flashings
- joints between the masonry and flashing should be pointed with cement mortar or suitable exterior grade sealant in accordance with the manufacturer's recommendations.

Where a flat or pitched roof over an enclosed area abuts a wall, or a balcony abuts a wall, cavity trays should be linked to the flashing to prevent water penetrating into an enclosed area. Horizontal flashings should provide weathering to a minimum of 75mm above the intersection with the roof.

Where a pitched roof abuts the wall at an angle:

- a stepped cavity tray linked to a stepped flashing should be used
- stepped flashings should be cut from a strip a minimum of 150mm wide
- stepped flashings should be a minimum of 65mm wide
- where slates, flat interlocking tiles or plain tiles are used, soakers (or a secret gutter) should be installed.





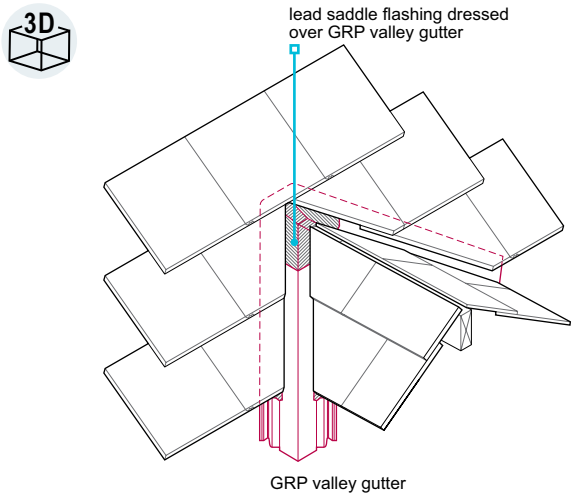
Flat roof intersection or changes in slope

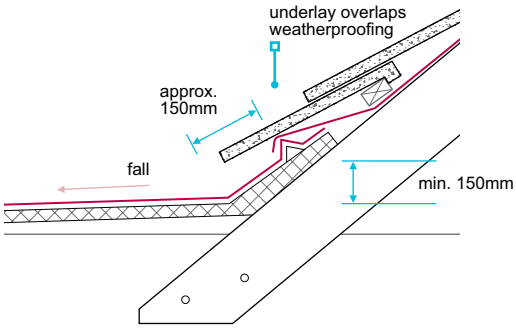
Where there is a change in the slope, or an intersection with a flat roof and:

- the change is 5° or more (e.g. at mansards and sprockets), flashings or soakers should be used
- a ridge meets the main roof, a saddle flashing should be used where a ridge meets the main roof.

Where a flat roof adjoins a pitched roof:

- the waterproof membrane should be carried up under the tiling to a height of 150mm above the flat roof, and lapped by the roofing underlay
- the lowest course of tiles or slates should not touch the roof membrane
- where the flat roof is over a dormer, the flat roof should have a fall to the front or sides.

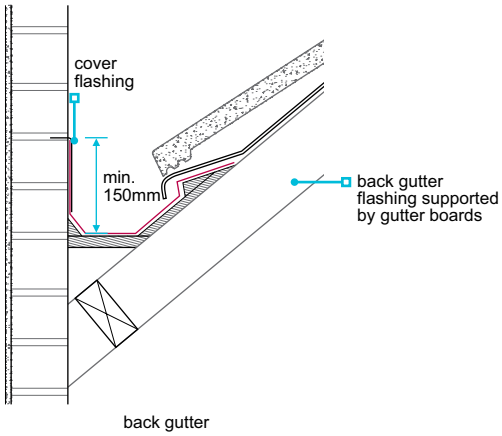


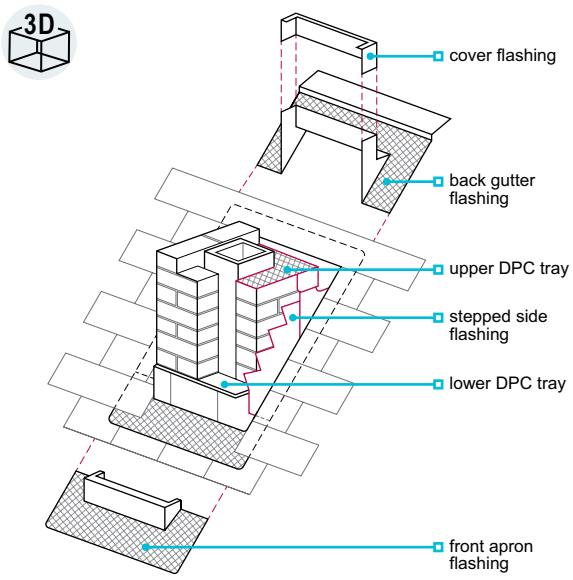


Projections through the roof

Where there is a projection through the roof:

- components should be installed according to the manufacturer's recommendations
- flashings should be provided (e.g. at chimneys)
- where pipes penetrate tiling, a weathertight joint should be formed using a lead slate flashing and upstand or a purpose-made one-piece accessory (supplied by the roof covering manufacturer); where lead slates are used they should be supported (e.g. using exterior grade plywood) to prevent sagging.





Copings

Copings, including those manufactured from natural stone reconstituted stone, and GRP, should be securely fixed to gable walls using suitably durable fixings, and be weathertight.

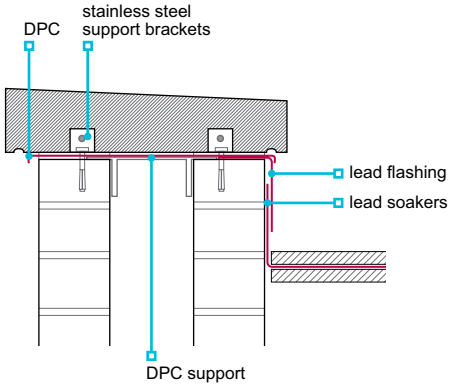
To resist wind uplift and gravitational forces, L-shaped brackets should be used to secure stone copings to masonry walls. The brackets should:

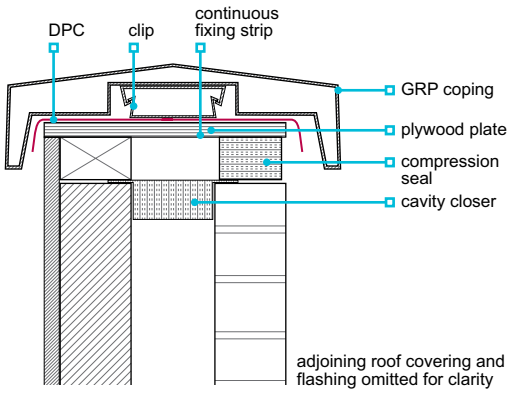
- have dowel bars that fit into restraint holes in the copings
- be manufactured from stainless steel (such as type 304 to BS EN 10088-2)
- be fixed to a solid piece of masonry, with fixings of a suitable length, gauge and durability.

DPCs should be installed under the coping to ensure that the wall is weathertight. The DPC should:

- be bitumen-based material to BS 6398, or other material assessed in accordance with Technical Requirement R3
- extend the full width of the wall
- be fully bedded in mortar
- be supported over the cavity.

Fixing methods that penetrate the DPC should be designed to ensure weathertightness. This can be achieved by extending the lower DPC under the bracket, and installing the next section of the DPC over it to create a lap that covers the fixing point.





Where GRP copings are used, they should:

- be fixed in accordance with the manufacturer's instructions
- include a DPC
- allow for normal downward movement in the timber frame.

Further guidance can be found in Chapter 6.2 'External timber framed walls'.

7.2.21 Valleys and hidden gutters

Valleys shall have suitable weathering details, including flashings, to resist the passage of moisture to the inside of the building.

Valleys, and the components used, should:

- be in accordance with the design
- have a finished pitch which complies with the minimum recommended for the roof
- be fixed in accordance with the manufacturer's recommendations
- small cut tiles should be avoided
- have a lead flashing (minimum code 4) or other suitable saddle flashing, at the head of each valley
- be formed using either preformed GRP, valley coursing tiles (plain tiles), valley trough tiles (interlocking tiles), non-ferrous metal or a proprietary system to Technical Requirement R3.

Where the roof covering is slate or plain tiles, the following may be used:

- A laced valley.
- A swept valley.
- A mitred valley with soakers.

Valleys using valley tiles

Where valleys are formed using valley tiles:

- purpose-made valley coursing tiles should be used where the roof uses plain tiles
- purpose-made valley trough tiles should be supported by gutter boards where the roof uses single lap interlocking tiles
- they should be mechanically cut to the correct rake
- adjacent coverings should be neatly cut to form a smooth junction, and preferably be cut from tile-and-a-half tiles
- they should be bedded in mortar with a minimum 100mm wide channel (minimum 125mm for pitches below 30°).

Lead-lined valleys

For lead-lined valleys, the tiles should be cut and bedded as for valley tiles, except that the mortar should be bedded on an undercloak (to prevent direct contact between the lead and the mortar). Mortar should not bridge the welt detail.

Lead should be:

- either code 4 (colour-coded blue) or code 5 (colour-coded red)
- supported on gutter boards of 19mm exterior grade ply, or as specified in the design
- laid in strips no longer than 1.5m
- lapped by a minimum of 150mm, where pitches are above 30°.

Proprietary gutter or valley systems

Proprietary gutter or valley systems should be in accordance with the manufacturer's recommendations, and securely fixed to suitable supports (exterior grade materials should be used).

7.2.22 Drainage

Roof drainage shall adequately carry rainwater to a suitable outlet.

Drainage should be:

- provided where roofs are greater than 6m^2; however, consideration should be given to providing drainage to smaller roofs such as dormer, porch roofs and balconies (see Clause 7.1.12)
- of a sufficient size to accommodate normal rainfall, and sized to cope with concentrated flows, i.e. where there are dormer roofs
- designed and fitted to prevent erosion of the lower surface, where water from a large roof surface discharges onto another surface
- fixed in accordance with the design, using the correct type of fittings for internal and external angles, outlets etc. to ensure efficient drainage of the roof
- supported and jointed in accordance with the manufacturer's recommendations
- insulated when passing through a home, in accordance with Chapter 8.1 'Internal services'
- installed ensuring gutters are provided with stop ends, and are laid with a sufficient fall towards the outlet, unless designed to be flat.

Where gutters are behind parapet walls, a suitably sized overflow should be provided.

Where a downpipe discharges above ground level, or above a drainage gully, the downpipe should be fitted with shoes.

7.2.23 Fascias and trim

Also see: Chapter 3.3

Fascias, bargeboards and soffits shall be appropriately fixed and treated against decay.

Table 14: Materials acceptable for facia boards

Exterior grade plywood	BS EN 636 Class 3
High density fibre reinforced calcium silicate board	BS EN 12467
Glass fibre reinforced cement (GRC) board	BS EN 12467
Proprietary products	Technical Requirement R3

When installing fascia boards and soffits:

- timber for external feature work should be free from waney edges, large knots, resinous pockets, splits and other unsightly defects
- timber for fascias, bargeboards and soffits should be pretreated with preservative
- where preservative treated timber is cut or planed, preservative should be applied to the cut edge
- where timber is to be painted, it should be knotted and primed on all surfaces before fixing
- where timber requires a stained finish, one coat of stain should be applied before fixing
- each joint should be cut and fixed neatly.

Fascia boards should be fixed:

- twice to each rafter
- with splayed butt joints.

7.2.24 Spandrel panels

Spandrel panels shall provide satisfactory performance.

Spandrel panels used in cold roof voids to create separation between dwellings or to form the inner leaf of gable walls should be designed, manufactured and installed to provide satisfactory performance. Items to be taken into account include:

- fire resistance
- acoustic transfer
- structural stability.

Spandrel panels that comply with guidance from the Structural Timber Association or the Trussed Rafter Association will generally be acceptable to NHBC.

Internal services

CHAPTER 8.1

This chapter gives guidance on meeting the Technical Requirements forinternal services, including:

- **the supply of hot and cold water**
- **plumbing**
- **gas**
- **electrical installations.**

NHBC

Raising Standards. Protecting Homeowners

8.1.1 Compliance

Also see: Chapter 2.1

Internal services shall comply with the Technical Requirements and take account of service entries, ground hazards and chemical attack.

Internal services which comply with the guidance in this chapter will generally be acceptable.

Adequate precautions against ground hazards and the entry of gas i.e. radon or gas, from landfill sites, should be provided as necessary. Further guidance can be found in BRE Report 211 'Radon: guidance on protective measures for new dwellings', and BRE Report 212 ' Construction of new buildings on gas-contaminated land'.

8.1.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Clear and fully detailed drawings should be available on site to enable work to be carried out in accordance with the design. Designs should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- Location of sanitary fittings.
- Drainage runs.
- Location and size of water storage cisterns and cylinders.
- Hot and cold water pipe runs.
- Central heating pipe runs.
- Underfloor heating pipe runs.
- Gas supply pipe runs.
- Electrical outlets, switches and consumer units.

8.1.3 Water services and supply

Also see: water regulations and guides, BS EN 806

Water services shall be based on the pressures and flow rates supplied from the incoming main. Components shall be selected and installed to ensure satisfactory service for the life of the system, with suitable precautions taken against corrosion and damage. Issues to be taken into account include:

a) suitability of materials and components
b) adequate supply
c) durability
d) protection from the cold.

Suitability of materials and components

Relevant standards for materials and components used in domestic water systems include:

BS EN 806	'Specifications for installations inside buildings conveying water for human consumption'.
BS EN 12897	'Water supply. Specification for indirectly heated unvented (closed) storage water heaters'.
BS EN 1057	'Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications'.
BS 1566	'Copper indirect cylinders for domestic purposes'.
BS 3198	'Specification for copper hot water storage combination units for domestic purpose'.
BS 7291	'Thermoplastics pipe and fitting systems for hot and cold water for domestic purposes and heating installations in buildings'.
BS 8558	'Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806'.

Adequate supply

The design and installation of the water services supply should:

- be in accordance with building regulations, statutory requirements and the recommendations of the water supplier
- ensure drinking water is provided at the kitchen sink direct from the supply pipe or, where this is impracticable, from a storage cistern containing an adequate supply of drinking water
- be based on a minimum 1.5 bar dynamic pressure at the stop valve inside the home
- ensure a minimum 20L/min flow rate is available at the stop valve inside the home
- account for pressure and flow rate reductions (a wider supply pipe may be required inside the home)
- account for pressure fluctuations and surges, which may occur within the system and potentially damage fittings (surge arresters may be required)
- ensure that stop valves within the curtilage and outside the home are protected by a shaft or box
- ensure service pipes are a minimum of 750mm below the ground surface – where this is not possible, adequate precautions should be taken against frost and mechanical damage
- ensure that underground ducts are sealed at both ends to prevent the entry of fluids, vermin and insects
- be of materials which are safe and minimise the risk of corrosion
- be in accordance with the recommendations of the water supplier, including compatibility of the supply with the materials and fittings.

The water system should be capable of being drained (hot and cold services separately).

Durability

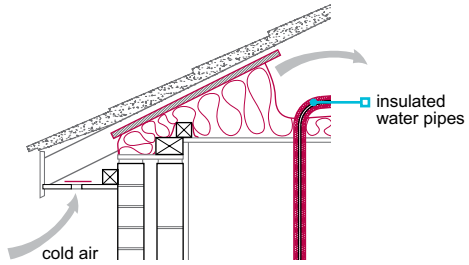
The hot and cold water service should be installed using corrosion resistant pipes and fittings.

In areas where pitting corrosion of copper cylinders occurs, it may be necessary to fit aluminium protector rods. These should be fitted during manufacture in accordance with the relevant British Standard. Sacrificial anodes should be installed where required by the water supplier.

Protection from the cold

To reduce the risk of freezing, water services should be located in the warm envelope of the home. Where they are located in unheated spaces, they should be insulated and not affected by cold. Insulation should be provided:

- around water services, including pipework (in accordance with Tables 1 and 2), cisterns and vent pipes (particular care is needed around bends and junctions, especially near openings to the outside air, such as eaves)
- as specified in the design (but not beneath a cold water tank)
- on each side of raised tanks in unheated roof spaces
- in accordance with BS 6700 or BS EN 806 and BS 8558.



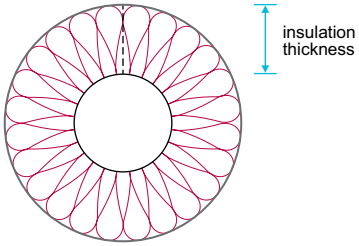


Table 1: Minimum insulation thickness to delay freezing inside domestic premises for cold water systems

Outside pipe diameter (mm)	Minimum insulation thickness (mm)			
	Thermal conductivity of material at 0°C W/(mK)			
	0.025	0.030	0.035	0.040
15	30	45	70	91
22-28	12	15	19	24

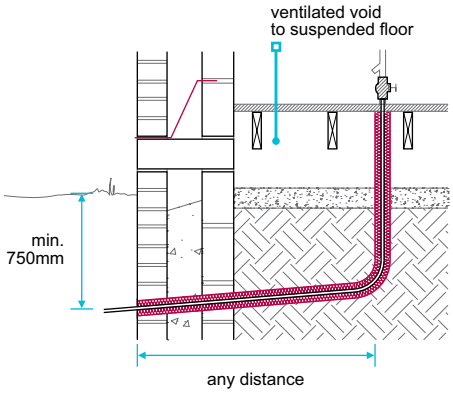
The conditions assumed for the table are:

- air temperature -6°C
- water temperature +7°C
- ice formation 50%.

Table 2: Examples of insulating materials:

Thermal conductivity W/(mK)	Material
Less than 0.020	Rigid phenolic foam.
0.020-0.025	Polyisocyanurate foam and rigid polyurethane foam.
0.025-0.030	PVC foam.
0.030-0.035	Expanded polystyrene, extruded polystyrene, cross-linked polyethlene foam, expanded nitrile rubber and improved polyethylene foam.
0.035-0.040	Standard polyethylene foam, expanded synthetic rubber and cellular glass.

Where the floor is of suspended construction, the underfloor water service should be insulated as it passes through the ground and the ventilated space.



8.1.4 Cold water storage

Cold water service shall be provided in accordance with statutory requirements and be adequate.

Cold water storage should be provided with suitable capacity and include primary feed cisterns where indirect water heating systems are installed. Cold water storage should be provided:

- to supply an open vented hot water storage system (where required by the water supplier)
- to supply cold water outlets (where not connected to the mains supply).

Cisterns should:

- be accessible for inspection and maintenance
- be protected by a rigid close-fitting cover (non-airtight) that also excludes light and insects
- have holes neatly formed with a cutter in the positions shown in the design
- be suitably supported.

BS 6700 provides the following recommendations:

- Storage capacity for small homes – only cold water fittings – 100-150L.
- Storage capacity for small homes – supplying hot and cold outlets – 200-300L.
- Storage capacity for larger homes – 100L per bedroom.

Warning and overflow pipes:

- should be provided at each cold water cistern, to a suitable external discharge, unless permitted by water regulations where it may be internal if it is conspicuous
- should be adequately sized (19mm minimum)
- should be situated 25mm from the shut-off water level in the cistern
- may dip below the water level in accordance with water regulations, terminate vertically downwards or be fitted with a horizontal tee where it discharges.

The cistern bottom should be continuously supported by materials such as:

- softwood boarding
- marine plywood
- chipboard type P5 to BS EN 312
- oriented strand board type OSB3 to BS EN 300, laid with the stronger axis (as marked on board) at right angles to the bearers.

Access should:

- be provided to the main roof space and voids that contain cisterns and tanks, etc. (not required to roof spaces containing only water pipes)
- be via an opening (access hatch) with a minimum width of 520mm in each direction
- not be located directly over stairs or in other hazardous locations
- include a minimum 1m² platform located for maintenance purposes
- include securely fixed boarded walkways between the opening and the cistern or other permanent equipment (boarding should be securely fixed without compressing the insulation).

8.1.5 Hot water service

Also see: BS 8558

Hot water service shall be provided in accordance with statutory requirements and be adequate for the demand and consumption.

Hot water services should be designed in accordance with Tables 3, 4 and 5, and:

- the minimum flow rate should be in accordance with the statutory requirements and generally be available; it may be less where the pressure and flow rate of the incoming supply falls below 1.5 bar
- have the design flow rate available at each outlet when the total demand does not exceed 0.3L/s (where simultaneous discharge occurs, the flow rate at individual outlets should not be less than the minimum rate).

Table 3: Flow rate and temperature requirements

Outlet	Design flow rate (1)		Minimum flow rate (2)		Supply temperature °C (3)
	L/sec	(L/min)	L/sec	(L/min)	
Bath (from storage)	0.30	(18)	0.15	(9)	48
Bath (from combi)	0.20	(12)	0.15	(9)	40
Shower (non-electric)	0.20	(12)	0.10	(6)	40
Wash basin	0.15	(9)	0.10	(6)	40
Sink	0.20	(12)	0.10	(6)	55

Notes

1 The design flow rate should be used to establish the hot and cold pipe sizes to provide the flow rate quoted at each outlet when that outlet is used on its own.

2 The minimum flow rate should be available at each fitting when that fitting is used simultaneously with one or more other fitting(s) as shown in Table 4.

3 The supply temperature is the temperature at the outlet. In accordance with BS 8558 the water temperature at an outlet or thermostatic mixing valve should be at least 50°C within 1 minute of running the water.

Table 4: Hot water demand and simultaneous use

Bathroom		Shower room		Hot water demand (5)	
Bath only	Bath + Shower (1)	1st Shower room	2nd Shower room	L/sec	(L/min)
✓ (2)				0.20	(12)
		✓ (3)		0.15	(9)
✓		✓		0.25	(15)
✓		✓	✓	0.35	(21)
	✓ (2)			0.20	(12)
	✓ (4)	✓		0.20	(12)
	✓ (4)	✓	✓	0.30	(18)
		✓	✓	0.20	(12)

Notes

1 Shower may be over the bath or in a separate enclosure within the bathroom.

2 Demand based on 'Design' flow rate of bath.

3 Demand based on minimum acceptable boiler output.

4 Demand based on use of the shower in preference to the bath.

5 The hot water system should supply at least the hot water demand stated and take account of distribution heat losses through the pipework. The suitability of instantaneous systems (combination boilers) will be limited by their performance as quoted by the boiler manufacturer.

Hot water storage should comply with the minimum capacity in Table 5 (based on a draw-off temperature of 60°C), and where appliances require greater volumes, the capacity should be increased accordingly.

Table 5: Minimum storage requirements

Shower only	Bath only	Bath and shower(s)[1]	Two baths
60L	120L	145L	180L

Note
1 Maximum of two showers (excludes instantaneous electric showers).

Where systems are heated by off-peak electricity, the storage capacity should be in accordance with the recommendations of the electricity supplier.

Where homes have one bathroom or shower room, the system should be able to provide adequate hot water:

- immediately after the bath has been filled, for tasks such as washing
- for a second bath after 20 minutes.

Where homes have two or more bathrooms, the system should be able to provide adequate hot water immediately after each of the baths have been filled, for tasks such as washing.

Where a shower is installed, adequate provision should be made to ensure that the outlet temperature of the water is not significantly affected by the use of other hot or cold outlets in the home. This may be achieved by the provision of a thermostatic shower mixing valve, the appropriate design of pipe sizes or dedicated supplies.

Instantaneous systems (using combination boilers) produce hot water on demand (generally at lower flow rates than storage systems), and should only be used where:

- simultaneous demand for hot water is limited. Where there are three or more outlets, the design for simultaneous discharge can omit the outlet at the kitchen sink
- storage combination boilers have the capacity as required in Table 5. Where boilers can control and prioritise hot water outputs the storage capacities can be less than the figures in Table 4 subject to manufacturer's recommendations on meeting the demand.

Storage systems provide higher flow rates than instantaneous systems, and:

- require a suitable space for the siting of the storage vessel
- where vented, should be provided with an expansion pipe.

Unvented hot water storage systems should be:

- assessed in accordance with Technical Requirement R3, or meet the requirements of BS EN 12897 and be the subject of third-party certification, e.g. Kitemarking (applies to both the assembled system and components)
- installed by competent installers.

Hot water cylinders should be:

- supported in accordance with manufacturer's recommendations
- installed vertically, unless designed otherwise
- accessible for maintenance
- insulated as specified in the design.

Where an immersion heater is fitted, it should be:

- appropriate for the type of water supplied to the home
- controlled by a thermostat
- located to facilitate replacement
- fitted with an on/off switch.

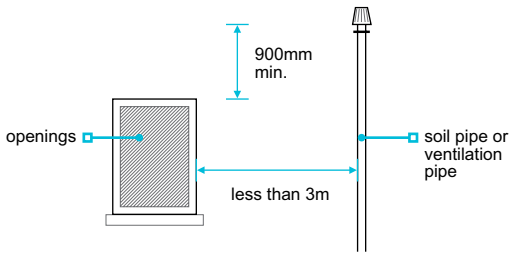
8.1.6 Soil and waste systems

Also see: BS EN 752 and BS EN 12056

Soil and waste systems shall be in accordance with relevant building regulations and installed to ensure that effluent is removed without affecting health or creating unnecessary noise and smell.

Soil and waste systems should be:

- in accordance with the requirements of the water supplier
- adequately ventilated at the head of underground drains (this may be by a soil pipe or separate ventilation pipe)
- adequately ventilated at each branch
- arranged to ensure foul air from the drainage system cannot enter homes (e.g. ventilated to 900mm above openings when within 3m)
- fixed neatly and securely to provide the correct falls
- fitted to prevent the entry of vermin.

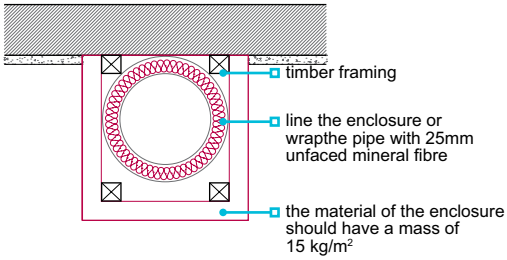


Air admittance valves should:

- be used to allow air to enter the drainage system (but do not avoid the need to ventilate it adequately)
- where used to terminate a soil pipe, comply with BS EN 12380 or be assessed in accordance with Technical Requirement R3
- not be positioned in areas which are liable to freezing
- have free movement of air around them which can be achieved by ventilation grilles, discreet gaps around the boxing or ventilation of the boxing into a ventilated roof void (the ventilation area should be 2500mm^2 minimum unless otherwise specified by the manufacturer)
- where positioned within the home, be accessible for maintenance.

Sound insulation should be provided to soil pipes passing through homes by:

- an encased boxing, using a minimum 15kg/m^2 board material and wrapping the pipe with a minimum 25mm of unfaced mineral fibre (the insulation should be continued through the thickness of each sound-insulating floor).



Sanitary fittings should be:

- installed with accessories, such as chains and plugs
- secured using non-ferrous or stainless steel screws or fixings appropriate to the weight of item being secured
- fitted without using excessive packing
- fitted to ensure WC lids and seats are stable when open.

Waste disposal units should be:

- provided with adequate support
- fitted with a tubular trap (not bottle or resealing)
- connected to the drainage system in accordance with the manufacturer's instructions.

The junctions of wall tiling with baths and showers should be made watertight using a flexible sealant to accommodate movement. The manufacturer's instructions should be followed.

8.1.7 Electrical services and installations

Also see: BRE report 'Thermal insulation: avoiding risks'

Electrical installations shall be provided in accordance with relevant regulations, codes and standards. The installation shall ensure safe and satisfactory operation and be protected from chemical attack.

Electrical services and installations should:

- comply with BS 7671 'Requirements for electrical installations'
- comply with BS 6004 'Electric cables. PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting'.
- have fittings and components located in accordance with relevant building regulations
- be installed in accordance with the manufacturer's recommendations
- ensure cables are not placed under, against or within thermal insulation, unless they have been appropriately sized and derated
- ensure PVC covered cables are not in contact with polystyrene insulation.

Rooms should be provided with the minimum number of 13A outlets listed in Table 6 (dual outlets count as two).

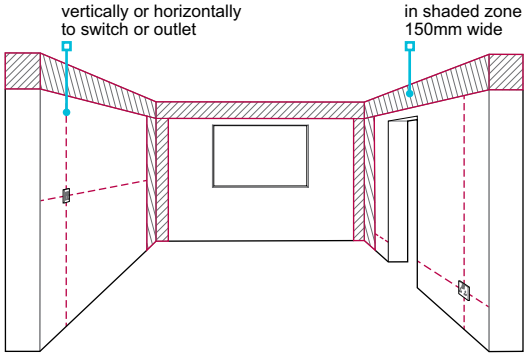
Table 6: Minimum number of outlets

Room	Outlets	Notes
Kitchen/utility	8	Where homes have separate areas, the kitchen should have a minimum of four outlets and the utility room four. Where appliances are provided, a minimum of three outlets should be free for general use.
Living or family room	8	A minimum of two outlets near the TV aerial outlet.
Bedrooms	6 (4)	A minimum of six outlets for the main bedroom and a minimum of four outlets for other bedrooms.
Dining room	4	
Landing	2	
Hall	2	

Cables without special protection, such as an earthed metal conduit, should be positioned:

- vertically or horizontally from the outlet or switch being served
- within the shaded zone in the diagram, or
- a minimum of 50mm from the surface of a wall, or a minimum of 50mm from the top or bottom of a timber joist, or batten in a floor or ceiling.

Where the position of switches or sockets can be determined from the reverse side of the wall or partition, the zone on one side of the wall or partition applies to the reverse side.



Lighting outlets

Lighting outlets should be provided:

- in each room, hall, landing and staircases
- with two-way switching at each floor level in a staircase
- in the common areas of homes and controlled by either manual switching or automatic light-sensitive controls.

Cooking spaces

Cooking spaces should:

- have a minimum 30A supply which is suitably switched and terminated
- have a 13A socket outlet where there is a gas supply
- where provided, have cooker panels located to the side of the cooker space.

Electrical supply to gas appliances

Where a gas appliance requires an electrical supply, a suitable fixed spur or socket outlet should be provided.

TV

Aerials are not required; however, one of the following should be provided:

- a concealed, coaxial cable from the roof void to a terminal outlet in the main living room
- a conduit and draw wire or suitable alternative.

8.1.8 Gas service installations

Also see: Chapters 6.2, 6.8, BS 6400 and BS 6891

Gas service installations shall be adequate and comply with the gas safety regulations, and be in accordance with relevant standards and codes to ensure safe and satisfactory operation.

Gas service installations should ensure:

- service pipework up to and including the emergency control valve and meter is in accordance with the requirements of the gas transporter, gas supplier and primary meter owner
- installation of pipework and appliances complies with relevant standards and codes including those published by the Institution of Gas Engineers and Managers (IGEM) or Gas Safe Register (GSR)
- where there is a gas supply to the home, a gas point at the cooker space should be provided. This is not required where an electric hob is provided
- where gas pipework is to be installed in timber frame, allowance is made for differential movement.

8.1.9 Meters

Also see: Chapter 6.1

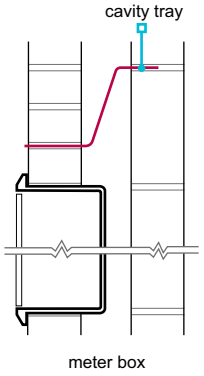
Openings in walls for meter cabinets shall be structurally adequate and prevent dampness entering the home.

Openings set into external walls should be provided with:

- DPCs and cavity trays
- lintels (except for purpose-designed built-in meter boxes).

Meters and associated equipment should be located to be reasonably accessible and not subject to damage.
Domestic meters may be of the following type:

- Built-in (to the outer leaf of the wall).
- Surface-mounted (on an external wall).
- Semi-concealed (sunk into the ground adjacent to the outer wall).
- Individually purpose-made compartments in accordance with the recommendations of BS 6400.



8.1.10 Space heating systems

Also see: Chapter 6.8

Where space heating is provided, it shall be in accordance with the relevant codes and standards, and ensure safe operation.

Where appropriate, space heating systems should comply with the following:

BS 5410	'Code of practice for oil firing'.
BS EN 14336	Heating systems in buildings. Installation and commissioning of water based heating systems.
BS 8303	'Installation of domestic heating and cooking appliances burning solid mineral fuels'.
BS EN 12828	'Heating systems in buildings. Design for water-based heating systems'.
BSRIA guide BG 4/2011	'Underfloor heating and cooling'.

Space heating appliances, including all components and controls, should be of a type approved by the relevant authority, including:

- Solid fuel – Solid Fuel Association, Heating Equipment Testing & Approval Scheme
- Electricity – British Electrotechnical Approvals Board
- Oil – OFTEC.

The provision of whole home or central heating is discretionary. Where provided, it should be designed in accordance with Table 7, recognised standards, and:

- the number of air changes per hour from kitchens and bathrooms should account for any mechanical ventilation
- where rooms contain open flued appliances, the rate of air change used for the design should be increased in accordance with BS EN 12828
- design temperatures should be verified by calculations and not by performance tests
- the main living room should have a heating appliance or a heat output as part of a whole home heating system
- temperature calculations should be based on a -3°C external temperature.

Table 7: Room temperatures and ventilation rates

Room	Room temperature °C	Ventilation rate (air changes per hour)
Living room	21	1.5
Dining room	21	1.5
Bedroom	18	1
Hall and landing	18	1.5
Kitchen	18	2
Bathroom	22	2
Toilet	18	2

8.1.11 Installation

Internal services shall not adversely affect the stability of the home and be installed to ensure satisfactory operation. Issues to be taken into account include:

a) fitting of pipes and cables
b) notching and drilling of joists
c) concealed services.

Fitting of pipes and cables

Services should:

- comply with Chapter 5.1 'Substructure and ground-bearing floors' where they pass through the substructure
- be protected by a sleeve, or ducted, when passing through structural elements and not solidly embedded
- not be located in the cavity of an external wall, except for electricity meter tails
- not be buried in screeds unless permitted by relevant codes of practice.

Where copper pipes are permitted in floor screeds, they should be:

- sleeved or wrapped so that they can move freely along the length and at joints and bends
- jointed with capillary joints.

Pipes should:

- be adequately secured with suitable clips or brackets
- be installed neatly with clips spaced to prevent sagging, but not restrict thermal movement
- have adequate falls (where appropriate)
- be installed with adequate room for thermal expansion and contraction to avoid damage and noise.

Metallic tape should be placed behind plastic pipework, where it is concealed behind wall surfaces, and would otherwise not be located by a metal detector or similar equipment.

Joints in pipes should be made:

- strictly in accordance with the manufacturer's instructions
- using lead-free flux recommended by the pipe manufacturer, with traces removed immediately after jointing.

Fire stopping should be provided around any services which penetrate fire-resisting floors, walls or partitions. Where a proprietary system, such as an intumescent seal is used, it should be installed in accordance with the manufacturer's instructions.

Notching and drilling of joists

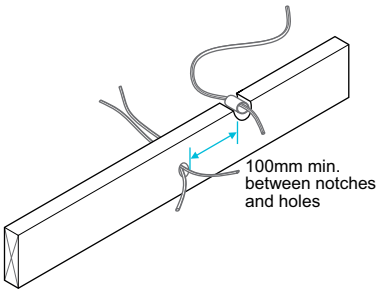
Notching, drilling and chasing to accommodate service pipes and cables should either:

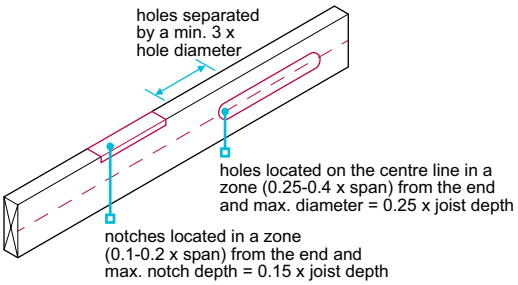
- comply with the clauses below, or
- be designed by an engineer.

Solid timber and studs

Table 8: Limits for notching and drilling solid timber members

	Location	Maximum size
Notching joists up to 250mm in depth	Top edge 0.1-0.2 x span	0.15 x depth of joist
Drilling joists up to 250mm in depth	Centre line 0.25-0.4 x span	0.25 x depth of joist
Drilling studs	Centre line 0.25-0.4 x height	0.25 x depth of stud





Where the structural strength is impaired by notching or drilling, the element should be replaced or correctly repaired.

Holes should be spaced at a minimum of three times the hole diameter.

Notches and holes in the same joist should be separated by a minimum horizontal distance of 100mm.

Instructions should be obtained from the designer when notching and drilling, where:

- the joist is deeper than 250mm, or
- the dimensions are not in accordance with Table 8, or
- it is close to heavy loads, such as those from partitions, cisterns, cylinders and stair trimming.

I-joists

Preformed holes are provided, and additional holes and notches should not be cut without the approval of the manufacturer.

Metal web joists

Services should run in the gaps between the metal webs. Conduits may need to be inserted before the joists are fixed in position.

Lightweight steel

Light weight steel should be used in accordance with Chapter 6.10 'Light steel framed walls and floors'.

Concealed services

Services concealed in walls or floors should be located so that significant cracking of the surface does not occur. Where chases in walls are necessary, their depth should not exceed:

- 1/6 thickness of the single leaf for horizontal chases
- 1/3 thickness for vertical chases.

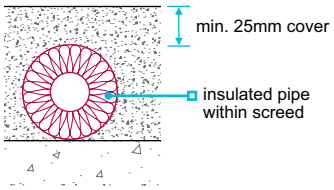
Hollow blocks should not be chased unless specifically permitted by the manufacturer.

Pipes under floor screeds should:

- be protected by wrapping or ducting
- have adequate allowance for thermal expansion, particularly at changes of direction.

Screed cover should be a minimum of 25mm over pipes and insulating material, and:

- where pipes cross, it may be necessary to form a duct to achieve adequate cover



- for in-situ suspended concrete floors, the location and depth of pipes should be approved by the designer.

8.1.12 Extract ducts

Also see: Chapter 8.3

Ductwork to intermittent and continuously running mechanical extract ventilation systems shall ensure satisfactory performance and durability. Issues to be taken into account include:

a) building integration
b) resistance to airflow
c) control of condensation
d) installation
e) terminals.

Building integration

The route of ductwork should take account of other building elements. Ductwork passing through structural elements should not adversely affect the structural or fire performance of the building. Where alterations to structural elements, such as I-joists, are required, this should only be carried out in accordance with the manufacturer's recommendations, or be designed by an engineer in accordance with Technical Requirement R5.

The fire requirements of the building should be in accordance with relevant building regulations and standards. Issues that should be taken into account include:

- suitable detailing of components passing through other elements of the building
- the location and type of dampers and firestops to be used
- the integrity of protected stairs and halls
- the integrity of walls and floors.

Resistance to airflow

Ductwork systems should be designed to minimise the resistance to airflow, and be formed from compatible components.

Rigid duct is preferable to flexible, but where flexible duct is used, it should be restricted in length to ensure that the airflow resistance does not prevent the designed ventilation rate from being achieved. Flexible duct should be installed:

- straight
- in accordance with the manufacturer's recommendations.

Bends should generally be formed with proprietary rigid components. Where flexible duct is used to form bends on an intermittent extract system, they should be restricted to a maximum of:

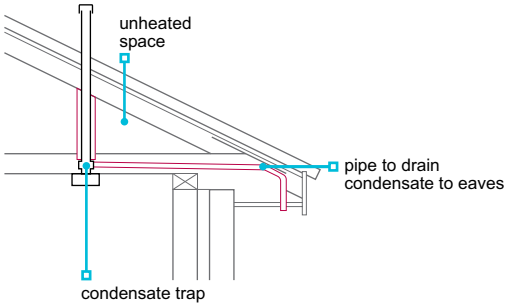
- two for systems up to 30 L/s
- one for extract rates higher than 30 L/s.

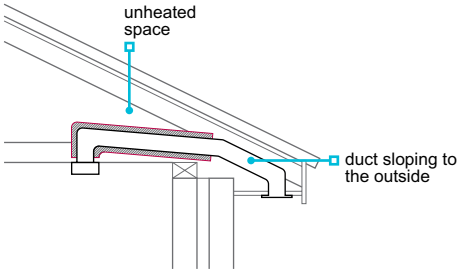
Control of condensation

Where extract ductwork passes through unheated spaces, it should be continuously insulated to achieve a thermal resistance equivalent to a minimum of 25mm of insulating material with a thermal conductivity of 0.04W/(mK). This can be achieved by using:

- suitable pre-insulated ductwork, or
- a proprietary insulation system.

Alternatively, the ductwork can be fitted with a condensate trap that discharges to the outside or installing the duct to slope to the outside.





Installation

Ductwork should be installed in a neat and workmanlike manner, be securely fixed, and have:

- adequate support throughout its length
- sealed mechanically fixed joints and connections.

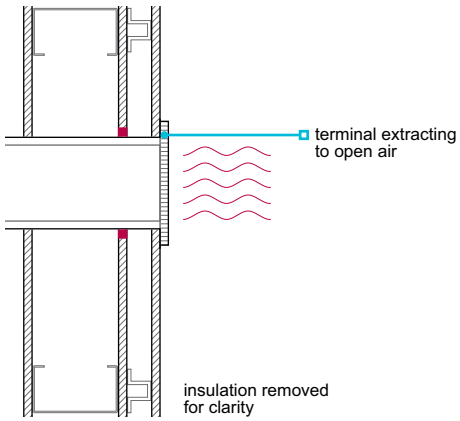
Where ductwork passes through an external wall, it should be positioned to slope slightly outwards to prevent water entering the building. Clips and supports for ductwork should be spaced at equal distances and in accordance with the ductwork manufacturer's recommendations. For rigid ductwork, they should not generally be more than 750mm apart.

Ductwork should not be in direct contact with other surfaces, such as plasterboard ceilings, that may transfer noise to the home.

Terminals

Ventilation systems should terminate freely to open air.

The air flow resistance of terminals should not adversely affect the performance of the ventilation system. Airflow resistance of terminals can be obtained through testing in accordance with BS EN 13141-2.



8.1.13 Testing and commissioning

Services shall be tested and commissioned to ensure satisfactory operation.

Services should be tested:

- in accordance with all relevant regulations and codes of practice
- where pipes are located under screeds (including air or water testing before and after the screed is laid)
- to ensure leaks or other defects are made good prior to the application of finish and handover of the home.

Before completion and handover of the building services should be commissioned in accordance with relevant regulations and codes of practice.

Low or zero carbon technologies

CHAPTER 8.2

This chapter gives guidance on meeting the Technical Requirements for low or zero carbon (LZC) technologies.

NHBC

Raising Standards. Protecting Homeowners

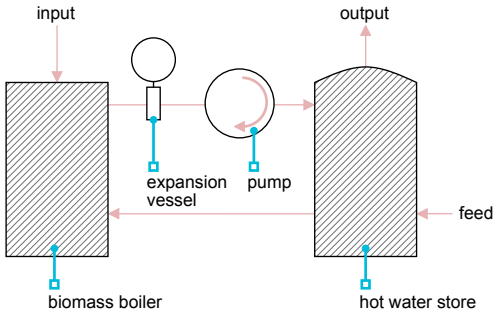
Introduction

This chapter provides guidance on low or zero carbon (LZC) technologies acceptable to NHBC. Other systems that follow the general principles of this chapter may also be acceptable, subject to specific agreement with NHBC. Additional requirements for solid fuel and oil fired boilers are given in Chapter 6.8 'Fireplaces, chimneys and flues'. Guidance on other internal services is given in Chapter 8.1 'Internal services'.

This chapter provides guidance on the following technologies:

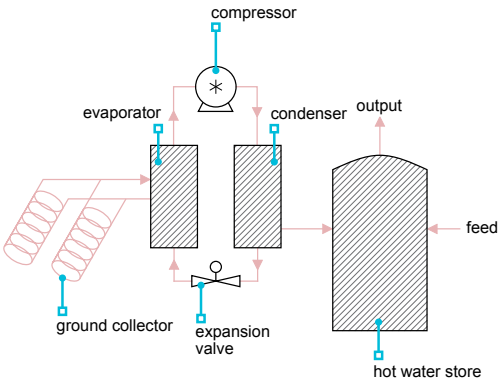
Biomass boiler

Systems which burn wood pellets or chips for space and/or water heating.



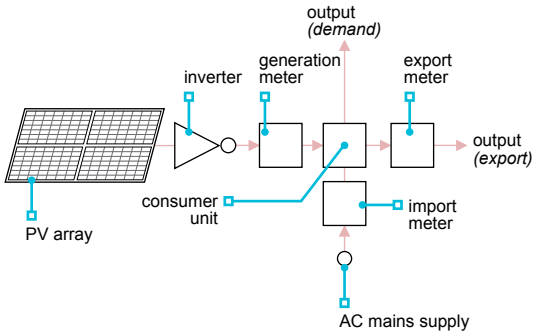
Heat pump

Systems which transfer heat from low energy sources. The most common sources are ground, outdoor air and exhaust air.



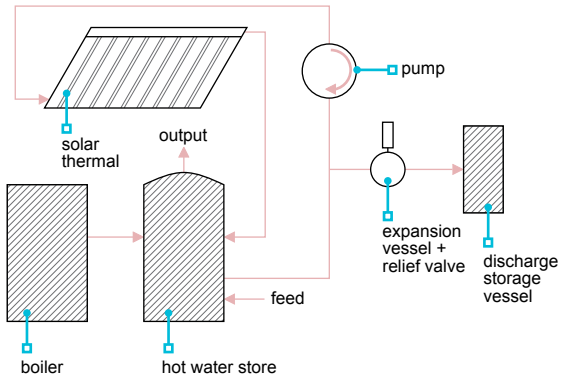
Solar photovoltaics (PV)

Systems which convert solar radiation into electricity.



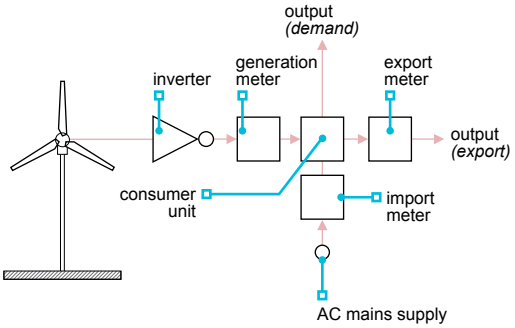
Solar thermal water heating

Systems which convert solar radiation energy to space and/or water heating.



Wind turbine

Systems which convert wind energy into electricity.



The illustrations provided within the introduction are generic and do not indicate the only possible systems acceptable to NHBC.

Definitions for this chapter

Controls	Controls are used to operate and/or regulate the system and may be electrical or mechanical.
Exclusion zone	An area where entry is restricted during periods when maintenance is in progress, to prevent risk of injury or loss of life.
Ground collectors	The component of a ground source heat pump system which absorbs heat from the ground. Collectors can be installed either horizontally or vertically in the ground. They may also be incorporated into proprietary foundation systems.
Interstitial condensation	Condensation caused by vapour from within the building condensing on colder surfaces within the wall construction, often occurring due to cold bridging.
Inverter	A device that converts direct current into alternating current.
Islanding (island mode operation)	Where an LZC technology feeds the network or local distribution system during a planned or unscheduled loss of mains supply.
Low or zero carbon (LZC) technologies	A term applied to renewable sources of energy, and also to technologies which are significantly more efficient than traditional solutions, or which emit less carbon in providing heating, cooling or power.
Open loop system stem	A heat pump system that extracts water from an underground source, pumps it through a heat exchanger and returns it underground.
Parallel electrical generation	A system in which building loads can be fed simultaneously from the national grid or electricity supply grid and on-site sources such as wind turbines and photovoltaic panels.
Performance	The manner or quality of functioning for a material, product or system.
Refrigerant pipework	Carries refrigerant between the indoor and outdoor unit of a split system. Normally made of copper and must be insulated and protected from damage.
Renewable energy	Energy from naturally available sources that can be replenished, including energy from the sun, the wind and tides, and from replaceable matter such as wood or other plant material.
Split system	A type of heat pump in which the condenser is located indoors, the evaporator is located outdoors, and the two are linked by refrigerant pipework.
Switchgear	The combination of electrical switches, fuses and/or circuit breakers used to isolate electrical equipment.

8.2.1 Compliance

Also see: Chapter 2.1 and ***www.microgenerationcertification.org***

LZC technologies shall comply with the Technical Requirements. Issues to be taken into account include:

a) relevant standards
b) product certification
c) operative competency.

LZC technologies that comply with the guidance in this chapter will generally be acceptable.

Relevant standards

LZC should comply with relevant standards including where applicable:

BS EN 12975-1	'Thermal solar systems and components. Solar collectors'.
BS EN 12976-1	'Thermal solar systems and components. Factory made systems'.
BS EN 61215	'Terrestrial photovoltaic (PV) modules - Design qualification and type approval'.
BS EN 14511	Parts 1-4 'Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling'.
BS EN 61400-1	'Wind turbines'.
BS EN 61400-2	'Wind turbines. Small wind turbines'.
BS EN 14785	'Residential space heating appliances fired by wood pellets'.
BS EN 12809	'Residential independent boilers fired by solid fuel'.
BS EN 303-5	'Heating boilers for solid fuels, hand and automatically fired, nominal heat output of up to 300kW. Terminology, requirements, testing and marking'.

Product certification

LZC technologies should have current certification confirming satisfactory assessment by an appropriate independent authority acceptable to NHBC.

Systems, products and installations that are assessed through the Microgeneration Certification Scheme (MCS) will generally be acceptable to NHBC. Certification and test documentation should be made available to NHBC upon request.

Other certification bodies or test documentation may be acceptable where they are considered by NHBC to be a suitable alternative.

Operative competency

LZC systems should be installed by operatives:

- competent and familiar with the system being installed, and
- certified to a standard acceptable to NHBC.

Installers who have been trained in accordance with the MCS installer standards will generally be acceptable to NHBC.

8.2.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to all appropriate personnel.

Design and specification information should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- Indication of which manufacturer and/or installer is responsible for each system and interface.
- A full set of current drawings.
- Manufacturers' specifications.
- Fixing schedule.
- Interface details.
- Specification for controls.
- On-site testing requirements.
- Commissioning schedule.

8.2.3 Clean Air Act

Biomass boilers installed in smoke controlled areas shall comply with relevant legislation.

Biomass boilers to be installed within a smoke controlled area should comply with the Clean Air Act 1993 or Clean Air (Northern Ireland) Order 1981.

8.2.4 System design

LZC technologies shall be designed to ensure satisfactory performance. Issues to be taken into account include:

a) location
b) acoustics
c) systems
d) compatibility
e) performance.

LZC technologies should be designed in accordance with the manufacturer's recommendations, certification scheme requirements and appropriate standards.

Location

The design and location of LZC technologies should take account of factors such as orientation, roof pitch and shading.

For stand-alone wind turbine systems, suitable exclusion zones should be provided in accordance with the manufacturer's recommendations and geographical location.

Acoustics

Design and location should take account of:

- internal and external noise
- vibration
- the effect on neighbouring properties, particularly the positioning of the LZC technology in relation to openings.

Systems

Each system should generally be supplied from one manufacturer as a package and not as individual components or materials. However, where components from more than one manufacturer are used, they should be compatible to ensure satisfactory performance.

Compatibility

LZC technologies should be installed so as not to adversely affect the performance of the building to which they are fixed, and in accordance with the manufacturer's recommendations.

Multiple systems should be compatible with each other.

Performance

LZC technologies designed to contribute towards space and water heating should be designed in accordance with the performance requirements in Chapter 8.1 'Internal services'.

8.2.5 Access

Appropriate arrangements shall be provided for the purposes of cleaning, inspection, maintenance and repair of LZC technologies.

Safe access should be provided to the LZC technologies, including switchgear, inverters, meters and controls. This is to enable the cleaning, inspection, maintenance and repair of systems. Access should be provided in accordance with the manufacturer's recommendations.

8.2.6 Handling, storage and protection

Materials, products and systems shall be handled, stored and protected in a satisfactory manner to prevent damage, distortion, weathering and degradation.

LZC technologies should be:

- transported, lifted, handled and stored in accordance with the manufacturer's recommendations
- delivered in sequence to avoid storage
- protected to avoid the risk of damage.

8.2.7 Sequence of work

LZC technologies shall be installed in accordance with a suitable schedule.

To ensure performance, certain LZC systems and ancillary components should be installed in a logical and timely sequence in accordance with the manufacturer's recommendations.

8.2.8 Location

LZC technologies shall be correctly located.

LZC technologies, including ancillary components should be located and identified in accordance with the manufacturer's recommendations.

8.2.9 Building integration

LZC technologies shall be securely fixed and not adversely affect the weather resistance of the building.

Foundations and anchor points for stand-alone LZC technologies should be designed by an engineer in accordance with Technical Requirement R5 to withstand the structural forces acting upon them.

The structure to which the LZC technology is attached should be assessed according to its ability to accept the loadings and prevent detrimental effects arising from movement or vibration. The design of the structure should take account of:

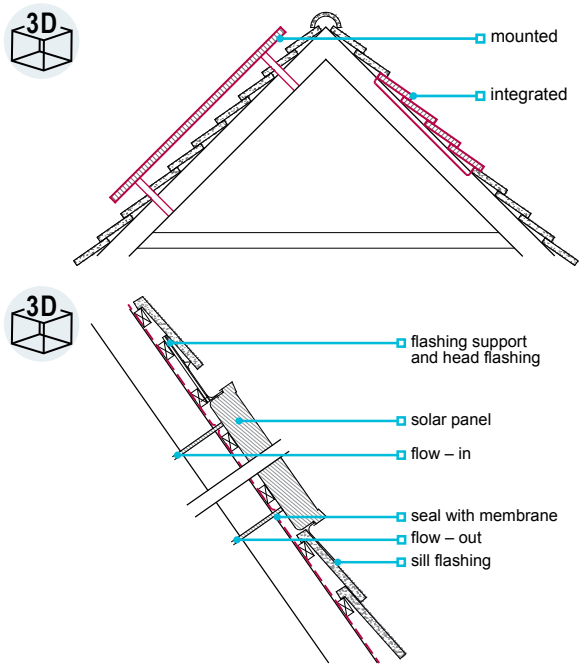
- the self-weight of the LZC components
- imposed loads
- wind loads
- snow loads
- dynamic loading (where relevant).

Notching, drilling or chasing of structural components to accommodate service pipes or cables should either comply with Chapter 8.1 ‘Internal services’, or be designed by an engineer in accordance with Technical Requirement R5.

Fixings, supports, bracketry and mounting frames should:

- accommodate all static and dynamic loads in accordance with the manufacturer’s recommendations
- be designed to take account of ventilation and drainage requirements of the LZC technology
- have adequate protection against corrosion.

Where two metals are to be joined, they should either be compatible or isolated, to prevent bimetallic corrosion. Aluminium and aluminium alloys should not come into contact with cementitious material.



All interfaces between the LZC technology and the building should ensure adequate weather resistance, sealed to limit air leakage and prevent moisture from reaching the interior or any part of the structure that could be adversely affected by its presence. The envelope should be weatherproofed using appropriate flashings and fixings. Weatherproofing details that rely solely on sealant are not acceptable. Flashings should be formed from the materials listed in Table 1.

Table 1: Materials for flashings

Flashing material	Guidance
Rolled lead sheet	Minimum code 4. BS EN 12588.
Aluminium and aluminium alloys	BS EN 485 and BS EN 573, 0.6-0.9mm thick and protected from contact with mortar by a coating of bituminous paint.
Zinc alloys	BS EN 988 and 0.6mm thick.
Copper	BS EN 1172 0.55mm thick and fully annealed. Where two metals are to be joined, they should be compatible and not cause bimetallic corrosion in that environment Alternatively, they should be isolated from each other.
Proprietary flashing, including plastic and composite.	Assessed in accordance with Technical Requirement R3.

To avoid potential surface or interstitial condensation, the design should take account of thermal bridging, particularly where any part of the system, including fixings, penetrates the thermal envelope.

8.2.10 Fixing

Also see: Chapter 2.1

LZC technologies shall be fixed using durable materials.

Fixings should comply with the types listed in Table 2.

Table 2: Materials suitable for fixings

Fixing material	Guidance
Phosphor bronze	NA
Silicon bronze	NA
Stainless steel	BS EN ISO 3506
Mild steel	Coatings to BS EN ISO 2081, BS EN ISO 2082, BS EN 1461, or other appropriate treatment in accordance with BS EN ISO 12944 or BS EN ISO 14713.
Aluminium alloy	BS EN 573 and BS EN 755
Stainless steel	BS EN 10088
Mild steel	BS EN 10346
Other materials	Assessed in accordance with Technical Requirement R3.

Materials that comply with recognised standards, which provide equal or better performance to those above, are also acceptable.

The type, size, number, position and fitting tolerance of fixings should be in accordance with the manufacturer's recommendations. Issues that should be taken into account include:

- the provision of suitable locking nuts and washers
- the isolation of dissimilar metals
- the isolation of aluminium from cementitious material.

8.2.11 Electrical installation requirements

The electrical installation shall be in accordance with relevant regulations.

Electrical installations should comply with BS 7671 'Requirements for Electrical Installations'.

Where parallel electrical generation occurs, inverters should have a current Engineering Recommendation G83/2 type test certificate and comply with all other parts of ER G83/2 for standard installations. Larger installations should comply with ER G59/3-2.

The electrical installation should be capable of being isolated from all other electrical sources when required, for maintenance or testing.

LZC technologies which generate electricity and are connected to the mains should automatically disconnect when there is a mains power failure. This is to prevent them from feeding the network or local distribution system during a planned or unscheduled loss of mains supply. This is known as 'islanding'.

8.2.12 Pipes, insulation and protection from cold

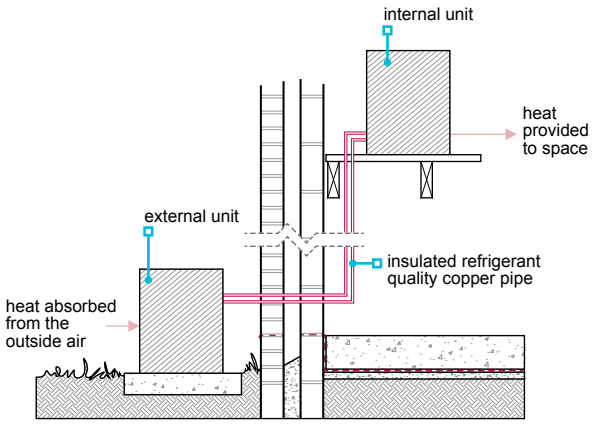
All pipework and insulation, including refrigerant pipework, shall ensure adequate performance and be designed to prevent freezing.

Materials used for pipes and insulation should be suitable for the intended purpose and provide satisfactory performance for the life of the system. Pipes should comply with relevant codes and standards or be independently assessed for their intended use in accordance with Technical Requirement R3. Insulation materials should be inert, and durable, and should not be adversely affected by moisture or vapour. They should also comply with relevant codes and standards or be independently assessed for their intended use in accordance with Technical Requirement R3.

Where there is a risk of pipes freezing, they should be insulated, particularly when at, or close to, ground level.

Refrigerant pipework connecting split systems should be of refrigerant quality copper pipe or other material as recommended by the manufacturer. The pipe should be insulated, and the insulation should incorporate a vapour control layer to prevent ice build-up.

Air source systems should incorporate an automatic defrost cycle and suitable condensate drainage.



8.2.13 Ground collectors

The installation of ground collectors shall take structural and environmental factors into account.

The depth and layout of ground collectors should be specified to avoid freezing of adjacent ground. Where open loop systems are proposed, consultation with the appropriate environment agency should be made and may require one or more of the following:

- A licence to investigate groundwater.
- An abstraction licence.
- A discharge consent.

Excavations for the installation of ground collectors should not adversely affect aquifers, foundations, drainage, water supply pipes and other services. Design should take account of local planning authority guidance, including excavations that are close to trees and hedgerows.

Ground collectors should be protected and tested prior to backfilling.

8.2.14 Fuel storage

Also see: The HVCA Guide to Good Practice Installation of Biofuel Heating (TR/38)

Fuel storage for biomass boilers shall be suitable for the installation.

Fuel stores should have appropriate:

- access for delivery
- fire detection and extinguishing equipment where elevated dust levels are expected
- volume to take account of peak load and period of demand
- fire resistance and separation to prevent fire and gases entering other parts of the building.

8.2.15 Safe discharge

Discharge from LZC technologies shall terminate safely.

Solar thermal water heating systems should discharge into a storage vessel. The discharge pipework and vessel should be suitable to withstand high temperatures.

8.2.16 Testing and commissioning

LZC technologies shall be tested and commissioned in accordance with the commissioning schedule.

The installer should check that the system is in accordance with the certification requirements, the manufacturer's recommendations and the design. Issues to be taken into account include:

- the safety of the system
- the correct installation of the system
- the correct operation of the system.

Upon completion, the installer should provide a certificate to confirm that the LZC technology has been installed, tested and commissioned in accordance with the above.

8.2.17 Handover requirements

Detailed information and instructions shall be provided to the homeowner.

The pack of information provided to the homeowner should include:

- user instructions for the systems installed
- contact details for the manufacturer and installer
- key components installed
- a completed manufacturer's certificate from an acceptable independent assessment organisation, MCS or suitable alternative
- a completed installer's certificate from an acceptable independent assessment organisation, MCS or suitable alternative
- details of the fuel type and source
- maintenance and servicing requirements
- warranties and/or guarantees for the LZC technology.

8.2.18 Further information

- *Renewable Energy Association (REA)*
- *CE72 Energy efficiency best practice in housing. Installing small wind-powered electricity generating systems: Guidance for installers and specifiers*
- *ER G59/3-4 Recommendations for the Connection of Generating Plant to the Distribution Systems of Licensed Distribution Network Operators'*
- *ER G83/2-1 Recommendations for the Connection of Type Tested Small-scale Embedded Generators (Up to 16A per Phase) in Parallel with Low-Voltage Distribution Systems*
- *BS EN ISO 14713-1:2017. Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. General principles of design and corrosion resistance*
- *BS EN ISO 14713-2:2009. Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. Hot dip galvanizing*
- *BS EN ISO 14713-3:2017. Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. Sherardizing*
- *BRE Digest DIG 489 Wind loads on roof-mounted photovoltaic and solar thermal systems'.*

Mechanical ventilation with heat recovery

CHAPTER 8.3

This chapter provides guidance on mechanical ventilation with heat recovery (MVHR) systems acceptable to NHBC.

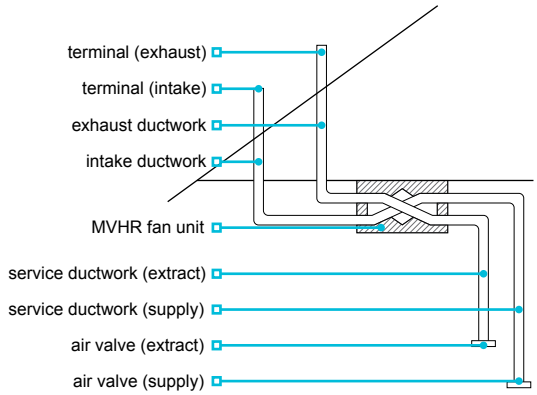
NHBC

Raising Standards. Protecting Homeowners

Mechanical ventilation with heat recovery 2020
CHAPTER 8.3

Definitions for this chapter

Air valve (extract and supply)	Wall or ceiling mounted fittings used to balance the flow rate of air between rooms; may be referred to as grilles.
Exhaust ductwork	Carries air from the fan unit and exhausts it to the external atmosphere.
Intake ductwork	Carries air from the external atmosphere to the MVHR fan unit.
MVHR fan unit	Unit that contains the fan(s), heat exchanger and filter(s).
Service ductwork extract and supply	Carries air between the air valves and the MVHR fan unit.
Terminal fittings	Located on the outside of the building to finish the intake and exhaust ductwork.



Also see: Chapter 2.1, Approved Document F, Domestic Ventilation Compliance Guide, Section 3 of the Technical Handbooks, Domestic Ventilation Guide in Scotland and Technical Booklets in Northern Ireland

8.3.1 Compliance

MVHR design, materials and sitework shall comply with the Technical Requirements, and be installed by competent operatives.

MVHR systems that comply with the guidance in this chapter and are in accordance with the relevant British Standards and building regulations will generally be acceptable.

MVHR systems should be installed by operatives:

- competent and familiar with the system being installed, and
- trained in accordance with the BPEC installer scheme, or other suitable scheme acceptable to NHBC.

8.3.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- Location of all ductwork runs, the fan unit and controls.
- Type, size and position of ducts and terminals.
- Direction of fall for 'horizontal' ductwork.
- Type and spacing of clips and fixings.
- Type and location of ancillary components, including those used for fire safety and acoustic purposes.
- Designed airflow-balancing figures for the system.

8.3.3 Building integration

Also see: Chapter 7.1 and 7.2

MVHR systems shall ensure compatibility with other building elements and not adversely affect the performance of the building. Issues to be taken into account include:

a) weathertightness
b) fixing of fan units
c) firestopping.

Weathertightness

Proprietary roof terminals should be used to ensure the weathertightness of the roof covering.

Fixing of fan units

MVHR fan units should only be fixed to parts of the building capable of taking the load. Where MVHR fan units are supported by framed structures, additional components such as noggings may be required to provide a secure fixing point.

Fan units should be located, orientated and fixed in accordance with the design, using the clips, brackets and fixings recommended by the manufacturer.

Firestopping

The MVHR system should not adversely affect the fire performance of the building. Issues to be taken into account include:

- ensuring that the fire requirements of the building are in accordance with relevant building regulations
- suitable detailing of components passing through other elements of the building
- location and type of firestops to be used
- integrity of protected stairs and halls
- integrity of walls and floors.

Proprietary fire components should be suitably tested, and specified to take account of the test conditions.

Relevant standards include:

BS 476	'Fire tests on building materials and structures.'
BS EN 1365-2	'Fire resistance tests for loadbearing elements. Floors and roofs.'
BS EN 1366-3	'Fire resistance tests for service installations. Penetration seals.'

8.3.4 Noise

MVHR systems shall be designed to minimise disturbance caused by noise.

MVHR fan units should be sized to run at their optimum speed and to provide suitable performance whilst taking the resulting noise and vibration into account. Specifying MVHR fan units that can provide the required airflow rates when running at less than full speed can reduce unnecessary noise.

Ductwork should be sized to allow air to pass freely without causing excessive noise disturbance. To reduce noise transfer along ductwork, a short length of flexible duct can be installed adjacent to air valves and fan units. Other issues to be taken into account include:

- noise between habitable rooms
- external noise
- location of the MVHR fan unit
- the type of mountings used to secure the MVHR fan unit.

8.3.5 Design considerations

Also see: Chapter 9.1

MVHR systems shall ensure compatibility and satisfactory performance. Issues to be taken into account include:

a) performance
b) systemised approach
c) type and position of air valves and terminals
d) control of condensation
e) protection from cold.

Performance

The MVHR system should be designed to provide satisfactory performance and be installed according to the design and manufacturer's recommendations. Variations from the design should maintain the satisfactory performance of the system and be approved by the designer.

Issues that should be taken into account include:

- ventilation rates as set out in appropriate building regulations and standards
- fan capacity, accounting for airflow resistance of the system
- ensuring the even distribution of airflow, taking into account airflow resistance, including from bends and fittings.

Airflow resistance should be calculated using figures for air valves and terminals determined in accordance with BS EN 13141-2 and data supplied by the duct manufacturer. Ductwork should be as direct as possible to reduce the number of bends.

Allowance should be made for air transfer within the home. Where gaps between the underside of internal doors and the floor finish are used for air transfer, the guidance in Chapter 9.1 'A consistent approach to finishes' should be considered.

Systemised approach

The MVHR system should be designed as a complete package, taking into account the performance of all components and materials, to ensure compatibility and the performance requirements of the system.

Particular consideration should be given where components from different manufacturers are specified on the same system.

Type and position of air valves and terminals

Air valves should be selected according to location and function, ensuring appropriate specification for:

- wall or ceiling location
- supply or extract function
- the velocity of the system.

To create cross-ventilation within a room and to ensure satisfactory operation, air valves on low velocity systems should be:

- positioned on the opposite side of the room from internal door openings
- a minimum of 200mm from walls, where located on a ceiling
- a maximum of 400mm from the ceiling, where located on a wall
- a minimum of 600mm (on plan) from hobs in kitchens
- positioned to account for the likely location of tall furniture and to avoid draughts over beds and seating areas
- lockable, where adjustable.

To prevent cross-contamination, intake terminals should generally be separated from exhaust terminals and other potential sources of pollution by a minimum of 1m measured on plan. Increased separation distances may be required between the intake and any:

- soil and vent pipe terminal
- boiler flue outlet
- biomass or solid fuel chimney terminal.

Terminals should prevent the entry of birds and animals.

Control of condensation

Ductwork should be insulated to prevent condensation formation where:

- it passes through spaces outside the insulated parts of the home, such as a roof void
- carrying cold air through spaces that are within the insulated parts of the home.

This can be achieved by using suitable pre-insulated ductwork, or a proprietary insulation system with a thermal resistance equivalent to a minimum of 25mm of insulating material, with a thermal conductivity of 0.04W/Mk.

Ductwork insulation, including that used for proprietary duct insulation systems and pre-insulated ducts should be:

- inert, durable and suitable for use with the ductwork system
- continuous and vapour resistant
- not adversely affected by moisture vapour
- installed in a neat and workmanlike manner to ensure that there are no gaps
- installed in accordance with the manufacturer's recommendations.

Where a vapour control layer is incorporated, the joints should be sealed using appropriate tapes or sealants as recommended by the manufacturer.

Table 1: Ductwork insulation

Type of duct	Ductwork continuously insulated	
	Ductwork located inside the insulated part of the home	Ductwork located outside the insulated part of the home
Intake	Yes	Yes
Exhaust	Yes	Yes
Service (supply and extract)	No	Yes(1)

Notes

1 Additional insulation should be provided to protect the system from the cold.

Any condensate that forms within the fan unit or ductwork should be able to drain to a suitable outfall. Fan units should be located to enable connection of the condensate drain to the soil and waste system via a dry trap.

Protection from cold

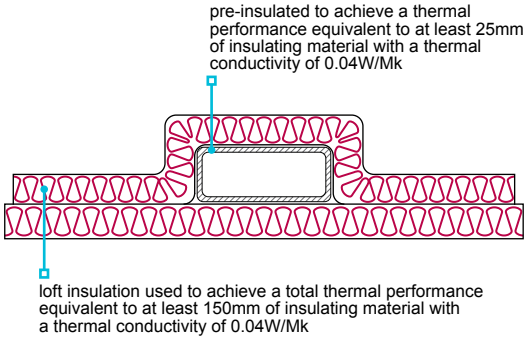
MVHR systems should be protected from the effects of cold. Issues to be taken into account include:

- performance in relation to indoor air quality
- the manufacturer's recommendations where any parts are located outside the insulated part of the home
- insulation of ductwork and other system components.

To prevent damage to the components and ensure satisfactory operation, MVHR systems should be fitted with automatic frost protection.

Horizontal sections of service ductwork, outside the insulated parts of the home, should be insulated to achieve a thermal resistance equivalent to at least 150mm of insulating material with a thermal conductivity of 0.04W/Mk. This may be achieved by installing the ductwork between the layers of horizontal insulation.

Condensate drains located outside the insulated part of the home should be insulated to prevent freezing.



8.3.6 Access and operation

MVHR systems shall be designed and installed to ensure that the fan unit and associated controls are easily accessible.

Table 2: Guidance for the suitable functioning of, and access to, the MVHR system

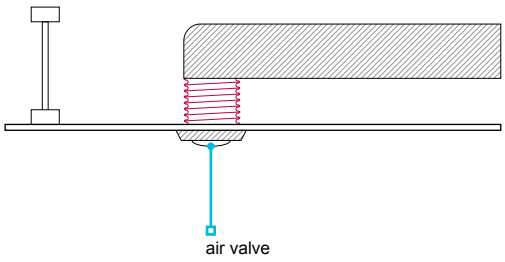
	Fan unit located inside the insulated part of the home	Fan unit located outside the insulated part of the home
Access	Access should not be obstructed and panels should be located and sized to enable routine servicing to be carried out.	A safe means of access, including a suitable walkway and a working platform 1m² immediately adjacent to the MVHR fan unit, should be provided. The walkway and platform should be designed to ensure the continuity of any insulation, and the supporting structure should be designed to take account of the additional load.
Control and functionality	Where a 'boost' function is provided, it should switch off automatically and be located in, or adjacent to, the room it serves. Where a 'summer bypass' function is provided, it should operate automatically and divert the airflow around the heat exchanger. The MVHR system should be capable of being isolated by a switched fused spur.	
Indication and controls	MVHR systems should include visual indicators showing maintenance and servicing requirements, and mode of operation. These should be visible from within the insulated envelope, not obscured from view, and be simple to use.	
Cleaning	To maintain operating performance, extract service ductwork and air valves should either be fitted with filters, or ductwork should be accessible for cleaning.	

8.3.7 Ductwork

Ductwork design and the materials used should be suitable for the intended purpose and not adversely affect the performance of the building.

Ductwork should:

- provide satisfactory performance for the life of the system
- be routed as directly as practicable
- be of a rigid or semi-rigid material suitable for use in MVHR systems
- be fixed in accordance with the manufacturer's recommendations.



Bends, connections and junctions should be formed using proprietary components that are part of the ductwork system.

Flexible ducting should:

- only be located adjacent to fan units or air valves
- not be more than 300mm in length
- not be used to form bends.

Where ductwork routes require alterations to structural elements, these should be in accordance with the manufacturer's recommendations or in accordance with Technical Requirement R5.

8.3.8 Fixing and jointing of ductwork

MVHR ductwork and insulation shall be installed to a satisfactory standard. Issues to be taken into account include:

a) fixing

b) jointing.

Ductwork should be securely installed in a neat and workmanlike manner.

Fixing

Parallel ductwork runs should be positioned to maintain a reasonably even gap.

To prevent condensate collecting, horizontal ductwork should be to a suitable outfall in accordance with the design, and installed to a true line to avoid localised dips.

Where ductwork passes through an external wall, it should be positioned to slope slightly outwards to prevent water entering the building.

Ductwork should be securely held in position by evenly spaced clips no more than 750mm apart, or in accordance with the ductwork manufacturer's recommendations.

Ductwork should not be in direct contact with other surfaces, such as plasterboard ceilings, that may transfer noise to the home.

Jointing

The method and materials used for jointing ductwork should be specified by the duct manufacturer, and be:

- durable and airtight
- securely fixed
- sealed with purpose-designed connections in accordance with the manufacturer's recommendations.

Where tapes and sealants are used, they should be suitable for the intended purpose and be recommended by the ductwork manufacturer. Issues to be taken into account in relation to the durability of the jointing method include:

- thermal movement
- moisture
- temperature
- compatibility with the duct material.

Tape should be installed in a neat and workmanlike manner, and surfaces should be dry and free from grease and dust before applying. Excess sealant should not extrude to the inside of the duct.

8.3.9 Commissioning and balancing

MVHR design, materials and sitework shall be tested and commissioned in accordance with the commissioning schedule.

Upon completion of the installation MVHR systems should be protected from dust during the construction of the home. Where possible the system should be switched off and dust covers applied to air valves.

Prior to completion of the home, the system:

- including ductwork and filters, should be checked to ensure it is clear from dirt and dust that may have accumulated during construction
- should be commissioned to confirm performance
- should be adjusted by using the air valves and controls to achieve the correct balancing and airflow rates
- should have air valves locked in position after correct commissioning and balancing.

Where the system cannot be balanced using the air valves and system controls, the complete system should be checked to ensure that it complies with the design.

Any changes from the design should be referred back to the designer. Adjusting the fan speed above the designed output may result in noise disturbance, and should be avoided.

A copy of the commissioning certificate should be made available to NHBC upon request.

8.3.10 Handover requirements

MVHR systems shall be provided with clear and detailed information and instructions that are handed over to the end user.

The pack of information should be in a format intended for a non-technical user and include:

- the commissioning certificate
- user instructions for the system and its controls
- user-friendly description and explanation of the system, including the location of components
- details of routine maintenance, e.g. changing/cleaning the filters
- method of cleaning the ductwork, where required
- guidance for the use of summer bypass and boost settings, where installed
- contact details of the manufacturer and installer
- details of the installed system, including part numbers for consumables
- details of any maintenance and servicing agreements.

A consistent approach to finishes

CHAPTER 9.1

This chapter gives guidance on meeting the Technical Requirements for finishes in new homes.

NHBC

Raising Standards. Protecting Homeowners

A consistent approach to finishes 2020
CHAPTER 9.1

9.1.1 Compliance

Also see: Chapter 2.1

Finishes shall comply with the Technical Requirements.

Finishes that comply with the guidance in this chapter will generally be acceptable.

This guidance:

- is intended to apply when the home is substantially complete and ready for NHBC pre-handover inspection
- will be used by NHBC both during the construction process and when conducting resolutions under section 2 of the Buildmark insurance cover
- should be considered in conjunction with relevant performance standards and guidance contained elsewhere within NHBC Standards
- uses tolerances and finishes considered to be appropriate for the house-building industry and takes precedence over other recommendations
- is not intended to deal with every situation which may arise, and discretion should be exercised.

Some elements may be subject to the effects of normal thermal or drying movement, and this may occur both before and after completion.

Some materials are not uniform and are not intended to be; this includes reclaimed materials. Some colour and texture variation is inevitable; this is often used as an aesthetic feature and should be recognised in appropriate tolerances or considered separately. Acceptability of finished appearances will be in the opinion of NHBC.

The nature and extent of work necessary to remedy minor variations from the tolerances and finishes given should be proportionate and appropriate to the circumstances: for example, how readily visible or extensive the affected part of the construction is.

9.1.2 External walls

Also see: Chapter 6.11

External walls shall have an acceptable finished appearance. Issues to be taken into account include:

a) fairfaced masonry
b) render
c) curtain walling
d) rainscreen cladding
e) brick slip cladding
f) timber cladding
g) tile hanging
h) cast stone elements.

Tolerances and appearance should be considered:

- for the entire wall (e.g. panels and interfaces), and not for the individual elements of the construction, such as individual bricks, individual bed joints, or design features and details (e.g. quoins, soldier courses and plinths)
- in daylight, and from a minimum distance of 10m.

Fairfaced masonry

Fairfaced masonry should:

- be reasonably uniform in texture, finish and colour, including mortar
- not have excessive colour banding
- not have significant cracks in the facing bricks or other damage, such as chips and marks greater than 15mm in diameter.

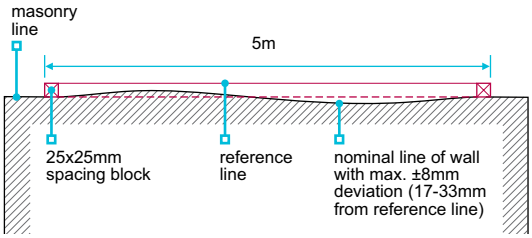
Where a fairfaced finish can only be achieved on one side (such as half brick walls), the other faces should be left neat and tidy.

Also note:

- Some mortar blemishes will occur on individual masonry units.
- Some variation will occur in the texture, finish and colour of mortar, in individual masonry units and generally over the wall.
- Efflorescence occurs naturally in some types of masonry. It is not harmful and generally disappears over time.
- Some brick products have features or marks which may be in excess of 15mm in diameter.
- Some minor shrinkage cracking may occur between masonry units (bricks and blocks) and mortar joints.

Fairfaced masonry should meet the following tolerances:

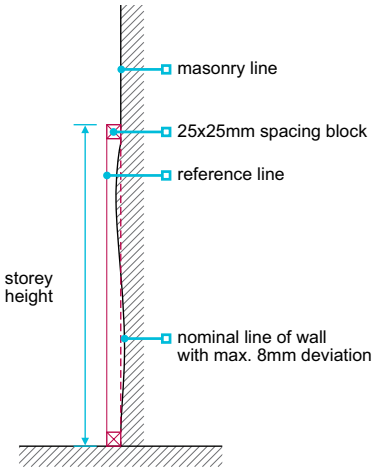
- adequately straight on plan, with a ±8mm maximum deviation in any length of wall up to 5m
- adequately straight in section, with a tolerance of ±8mm per storey height (up to 3m)
- a maximum of 8mm from plumb in any storey up to 3m. Taller walls should be a maximum of 8mm from plumb per storey and 12mm in total
- a maximum deviation of 4mm over 1m at external reveals.



straightness in plan

Example:
Using 25mm wide spacing blocks, the masonry line should be 17-33mm from the reference line.

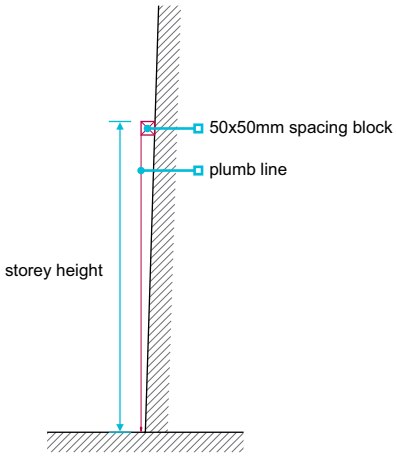
Spacing block dimensions are a guide, and final dimensions should ensure the reference line is kept clear of the wall face.



straight in section

Example:
Using 25mm wide spacing blocks, the masonry line should be 17-33mm from the reference line.

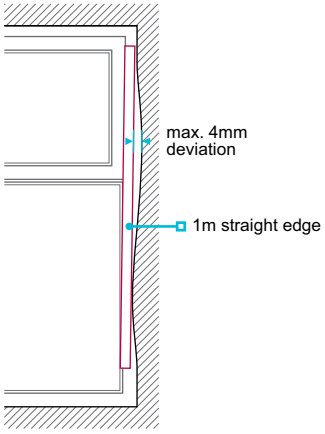
Spacing block dimensions are a guide, and final dimensions should ensure the reference line is kept clear of the wall face.



plumb in section

Example:
Using 50mm wide spacing blocks, the plumb bob should be 42-58mm from the wall, measured at between 2.5-3m from the spacing block.

Note:
Spacing block dimensions are a guide, and final dimensions should ensure the plumb line is kept clear of the wall face.



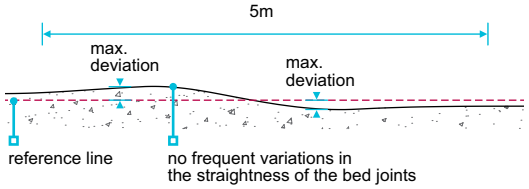
straight at reveals

Bed joints should be reasonably straight, measured along the top of a given row of bricks, with:

- a maximum deviation from straightness of ±8mm in any 5m section of wall.

The thickness of an individual bed joint should not vary from the average of the next eight successive joints by a maximum of ±1.5mm.

Straightness of bed joints



Example of how to determine if bed joint thickness is acceptable

Measure and add 8 successive bed joints and divide by 8 to determine the average size:

11+10+12+10+11+9+11+10 = 84

Divide by 8 = 10.5mm

Therefore, the acceptable range of the bed joint below the 8 measured bed joints is 9-12mm.

Perpend joints should not cumulatively displace in the same direction for more than 5 joints. The centre line of any perpend joint should generally be within ±15mm of the centre line of the next 5 successive perpend joints.

Also note:

- to achieve setting out, perp joints in masonry panels between openings may be offset with the perp joints in the panels above and below. The joints within the panel should not cumulatively displace.

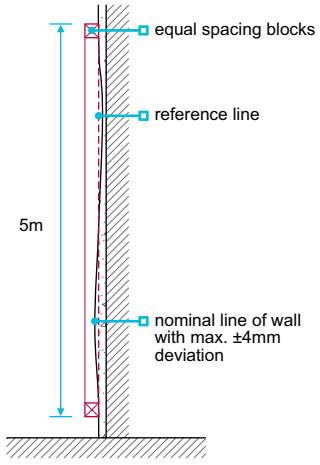
Render

Render should:

- be reasonably consistent in texture, finish and colour
- be flat, within a maximum ±4mm vertical and horizontal deviation in 5m
- be free from crazing (a set of hairline cracks, generally less than 1mm in depth and no more than 0.2mm wide).

Also note:

- There may be some colour variation in appearance due to differences in suction of the background and orientation of the wall.
- Daywork joints, patching and other repairs may be visible but should not be unduly obtrusive.
- Some localised hairline cracking is likely to occur in both traditional render and proprietary render systems. Such cracking and crazing should not impair the performance of the home.
- Areas of render in close proximity to features (e.g. bell casts) are excluded from the tolerance.
- Flatness is measured in a similar way to straightness and plumb of masonry.



straightness in section

Example:
Using 25mm wide spacing blocks, the masonry line should be 21-29mm from the reference line.

Spacing block dimensions are a guide, and final dimensions should ensure the plumb line is kept clear of the wall face.

Curtain walling

Curtain walling should be within:

- reasonable tolerances and appearance for the materials
- a maximum deviation of ±2mm in any storey height or structural bay width, and ±5mm overall, unless otherwise specified in the design.

Rainscreen cladding

Rainscreen cladding should be within:

- reasonable tolerances and appearance for the materials
- a maximum deviation of ±3mm in any storey height or structural bay width, unless otherwise specified in the design.

Brick slip cladding

Brick slip cladding should meet the same tolerances as fairfaced masonry.

Timber cladding

Variation in colour may occur in uncoated timber exposed to the weather, and the rate and extent may vary.

Also note:

- The effects of normal weathering may cause certain uncoated timber, over time, to develop a silver/grey colour.

Tile hanging

Panels should be reasonably uniform in appearance, particularly at abutments. Tiles should not have significant variations in texture, finish and colour. See Clause 9.1.13.

Cast stone elements

Cast stone should be reasonably uniform in both colour and texture.

Also note:

- Efflorescence, fungal growth and colour variation may occur due to orientation, shading and pollution.
- Surface abrasions and chips should be repaired in accordance with the manufacturer's recommendations.

9.1.3 Internal walls and ceilings

Internal walls and ceilings shall be built to appropriate tolerances and have an acceptable finished appearance. Issues to be taken into account include:

a) plastering and dry lining
b) walls and ceilings
c) skirtings.

Plastering and dry lining

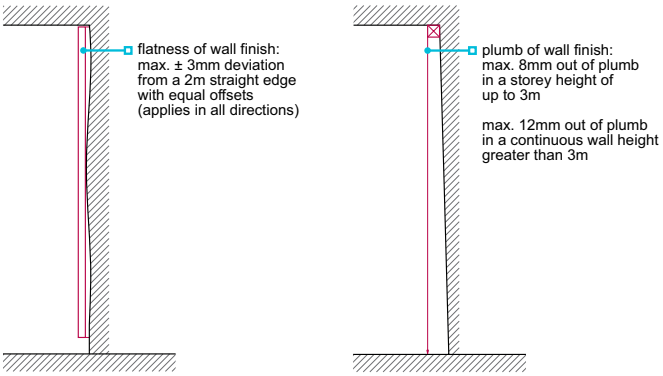
Plastered and dry lined surfaces should:

- not have board joints readily visible and be within a maximum ±3mm deviation, measured using a 450mm straight edge with equal offsets
- be viewed from a distance of 2m in natural daylight with no artificial light shining on the surface. Wall lights and/or uplighters should be switched off.

Walls

Walls should:

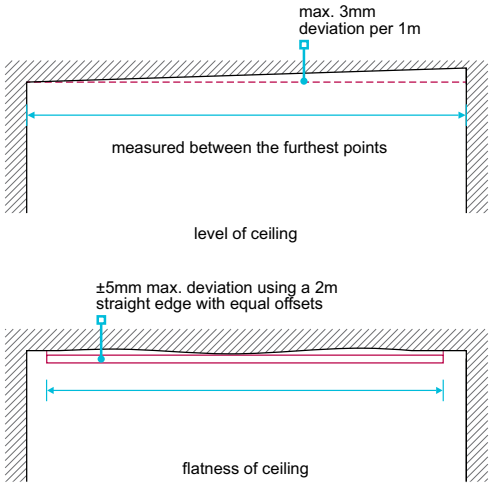
- be reasonably uniform, although there may be minor textural differences around lights and other fittings
- have no visible gaps between fittings and the surface (e.g. around switch plates)
- have jointing tape fully covered and unobtrusive in the finished surface
- have flat walls and within a ±3mm deviation measured using a 2m straight edge with equal offsets
- be a maximum of 8mm from plumb for walls up to 3m high. Taller walls should be a maximum of 8mm from plumb per storey and 12mm in total.



Ceilings

Ceilings should be:

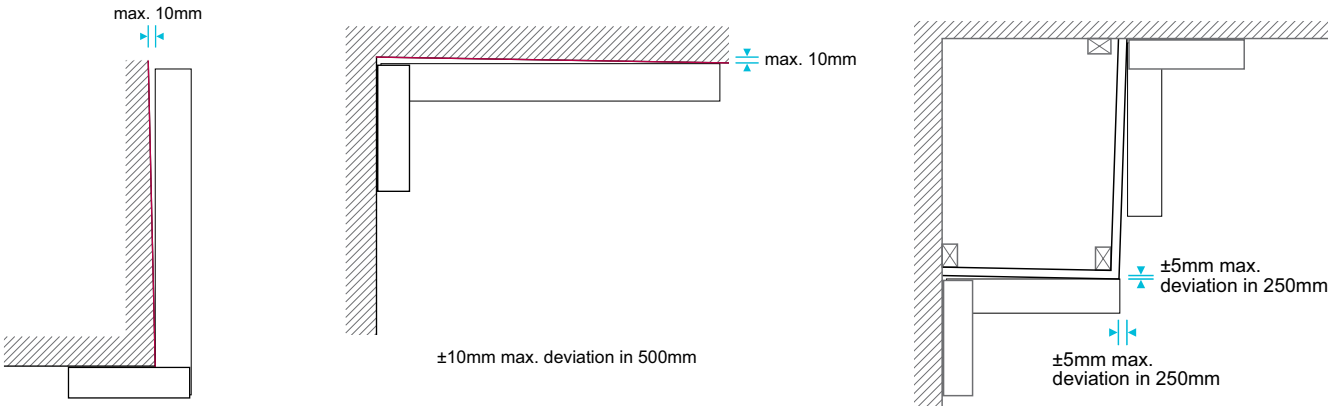
- level within a 3mm deviation per 1m for ceilings up to 6m across (measured at the furthest points across the full width of the ceiling)
- a maximum of 20mm out of level for ceilings over 6m across
- flat within a ±5mm deviation, measured using a 2m straight edge with equal offsets.



Setting out of corners, duct casings, access covers and any associated framing should be:

- square
- neat and tidy
- provided with an appropriate decorative finish.

Tolerances for corner details



±10mm max. deviation from square in 500mm

Also note:

- In plastered walls and ceilings, some tooling marks may be visible.
- Some cracking (up to 2mm wide) may occur at wall, floor and ceiling junctions, due to shrinkage and differential movement of materials.
- Small cracks may occur in wall finishes which pass across floors (e.g. in staircase walls).
- Where stair strings abut a wall, a crack of up to 4mm may appear as a result of shrinkage of materials.

Skirtings

Where skirtings are installed:

- the gap between the floor finish (without coverings) and the bottom of the skirting should not exceed 5mm at the time of completion
- joints should present a continuous appearance when viewed from a distance of 2m in daylight (some initial shrinkage of the skirting may already be evident at completion of the property).

Also note:

- The gap between the floor finish and the skirting may increase due to normal drying out, shrinkage and/or deflection, particularly in timber floors.
- Gaps may appear at joints and corners due to shrinkage, and between the wall finish and skirting due to drying out, shrinkage and fixing position.

9.1.4 Doors and windows

Doors and windows shall be installed to appropriate tolerances, including openings in walls and external openings viewed from the inside.

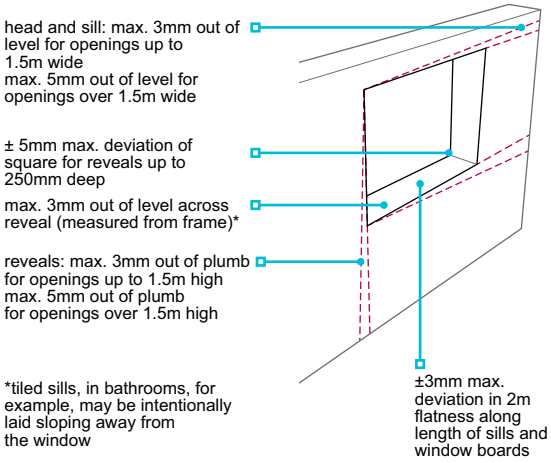
Internal openings in walls should:

- be flat along the length of sills and window boards, with a maximum deviation of ±3mm in every 2m
- have level heads and sills, a maximum of 3mm from level for openings up to 1.5m, and 5mm where longer
- have plumb reveals, a maximum of 3mm from plumb for openings up to 1.5m high, and 5mm where higher
- be level within 3mm across the sill measured from the frame (tiled sills, in bathrooms, for example, may be intentionally laid sloping away from the window)
- be square with the window, with a maximum deviation of ±5mm for reveals up to 250mm deep.

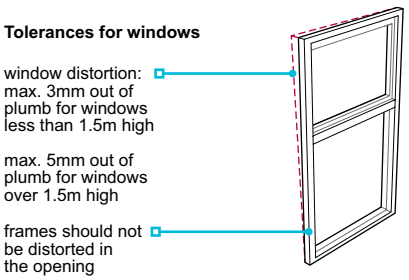
Window frames should not be distorted in the opening, and a maximum from plumb of:

- 3mm when up to 1.5m in height
- 5mm when larger.

Tolerances for internal openings



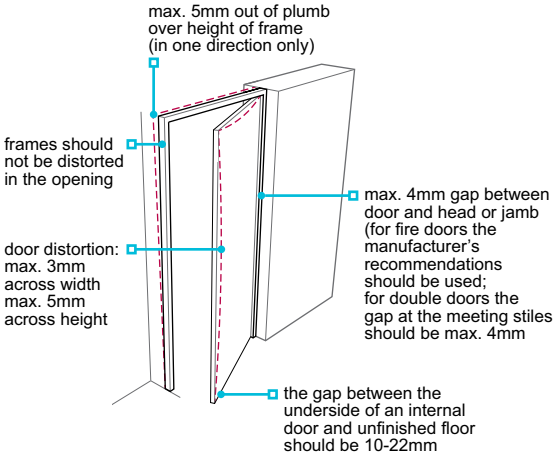
Tolerances for windows



Internal doors

Internal doors and frames should always be installed in accordance with the manufacturer's recommendations, not be distorted in the opening, and:

- frames should be within 5mm of plumb over the height of the frame and not out of plumb in two directions
- the gap between the door and head or jamb should be a maximum of 4mm (for double doors, the gap at the meeting stiles should be within 4mm) and uniform
- distortion across doors should be limited to a maximum of 5mm in height, and 3mm in width
- the gap between the underside of the door and unfinished floor should to between 10mm and 22mm. The ventilation requirements for the building need to be taken into account when determining the gap beneath internal doors.



Fire doors

Fire doors should be installed in accordance with the manufacturer's recommendations. The tolerances in this clause are without prejudice to satisfactory performance for ventilation and fire resistance.

External doors

External doors and frames should be installed in accordance with the manufacturer's recommendations, not be distorted in the opening, and:

- frames should be within 5mm of plumb over the height of the frame and not be out of plumb in two directions
- distortion across the door should be limited to a maximum of 5mm in height and 3mm in width.

9.1.5 Floors

Floors shall be built to appropriate tolerances.

Floors should be:

- level within a 3mm deviation per 1m for floors up to 6m across (measured at the furthest points across the full width of the floor)
- a maximum of 20mm out of level for floors over 6m across
- flat within a ±5mm deviation, measured using a 2m straight edge with equal offsets.

Underfloor service ducts should be constructed so that the cover is level with the adjacent floor finish. The selection of floor finish should take into account that drying shrinkage of the floor may result in minor differences in level between the floor and duct cover, which may be more evident with some types of thin floor coverings.

9.1.6 Glazing

Glass shall be free from undue defects.

Glass should be checked in daylight, from within the room and from a minimum distance of 2m (3m for toughened, laminated or coated glass). The following are acceptable where they are not obtrusive or bunched:

- bubbles or blisters
- hairlines or blobs
- fine scratches not more than 25mm long
- minute particles.

The above does not apply to areas within 6mm of the edge of the pane, where minor scratching may occur.

9.1.7 Ceramic, concrete, terrazzo and similar tile finishes

Ceramic, concrete, terrazzo and similar tile finishes shall have an appropriate appearance.

For ceramic, concrete, terrazzo and similar tile finishes:

- joints should be straight and in alignment, unless the tiles are, by design, irregular in shape
- wall tile joints should be a minimum of 1.5mm for ceramic tiles, 2mm for smooth natural stone tiles and 6mm for textured tiles
- floor tile joints should be a minimum of 3mm and proportionally wider for larger tiles, unless otherwise specified by the manufacturer
- joints in floor tiles should generally not exceed the tile thickness, although wider joints up to 10mm may be necessary to accommodate dimensional irregularities in some tiles
- should limit the effect of dimensional irregularities, with joints suitably arranged to maintain a regular appearance
- the variation in surface level should be within ±3mm measured using a 2m straight edge with equal offsets
- the variation in surface level between adjacent tiles should be 1mm or less where the joint is up to 6mm wide, or 2mm or less where the joint is over 6mm wide.

9.1.8 Fitted furniture

Fitted furniture shall have an appropriate appearance.

Fitted furniture, including doors and drawers, should:

- be visually aligned (vertically, horizontally and in plan), and there should not be significant differences in level at the intersection of adjacent worktops
- operate as intended by the manufacturer
- have uniform gaps between adjacent doors and/or drawers where appropriate
- not have conspicuous abrasions or scratches on factory-finished components when viewed in daylight from a distance of 0.5m.

Also note:

- No dimensional tolerance has been set for gaps between adjacent doors and/or drawers or for their alignment, because some variation will be necessary to take account of adjustments as part of the fitting process.
- No dimensional tolerance has been set for the abutment of adjacent worktops due to the variety of materials available and because minor variations, even with manufactured products, are inevitable and small differences in height may be unavoidable.
- Fitted furniture should be viewed from a distance of 0.5m.
- Conspicuous surface abrasions caused during installation should be removed in accordance with the manufacturer's recommendations, which may include filling, polishing out, respraying or painting as appropriate.
- In rooms or areas where there is no daylight, scratches should be viewed in artificial light from fixed wall or ceiling outlets and not from portable equipment.
- Kitchen units should not delaminate, including those located near hobs and extractor fans.

9.1.9 Joint sealants

Joint sealants shall have a neat and tidy appearance.

Sealants should be tooled to:

- remove blisters and irregularities
- achieve a compact, smooth neat surface finish.

Also note:

- Joints should be viewed from a distance of 2m, where possible, depending on the location (e.g. showers and baths may make this impossible).

9.1.10 Paint finishes

Painted and varnished surfaces shall be even in appearance and free from conspicuous runs and prominent brush marks.

Painted and varnished surfaces should:

- be reasonably smooth and free from nail holes, cracks and splits
- have joints filled
- be reasonably uniform in colour, texture and finish.

Also note:

- Surfaces should be viewed in daylight from a distance of 2m and not by shining artificial light on the surface. Wall lights and/or uplighters should be switched off.
- Timber surfaces may show limited raised grain, and the colour and texture may also vary.
- Drying shrinkage of timber may cause cracking of the paint finish, particularly where joints occur in plaster and woodwork.
- Where painted surfaces are touched up, minor colour variations may occur.
- External finishes will dull over time, depending on a number of factors such as exposure to sunlight, rain and pollutants.
- Resin can exude from knots, causing discoloration of paintwork, even though modern primers contain a compound to limit this.
- Site-decorated trim, such as architrave and skirting, may have a different finished appearance from factory-finished components, such as doors.

9.1.11 Sanitary ware

Baths, shower trays and basins shall be free from scratches, chips and other damage at the time of handover.

Sanitary fittings, such as baths, shower trays and basins, should not have conspicuous abrasions, scratches or chips when viewed in daylight from a distance of 0.5m.

Also note:

- In rooms or areas where there is no daylight, scratches should be viewed in artificial light from fixed wall or ceiling outlets and not from portable equipment.

9.1.12 Other surfaces and components

Other surfaces and finishes shall have an appropriate appearance.

Other surfaces and finishes, such as fascia boards, meter cabinets and radiators, should:

- be reasonably smooth and free from nail holes, cracks and splits
- have joints filled
- be reasonably uniform in colour, texture and finish.

9.1.13 Pitched roof coverings

Pitched roof coverings shall have an acceptable finished appearance.

Tiles and slates should:

- be reasonably uniform in texture, finish and colour
- be suitably mixed to avoid excessive colour banding.

Also note:

- Some minor blemishes will occur on individual tiles and slates.
- Some minor variations will occur in the texture, finish and colour of individual tiles and slates.
- Efflorescence occurs naturally on some types of tile. It is not harmful and generally disappears over time. Tiles which have efflorescence when laid should be suitably mixed to avoid a patchy appearance.

9.1.14 Garages

Garages shall have an acceptable appearance.

Garage walls, floors and roofs should be built to appropriate tolerances.

Also note:

- Cracks up to 2mm wide in unplastered blockwork walls may be evident due to thermal movement and shrinkage.
- Garage floors may be installed with falls for drainage or fire separation. Where garage floors have not been sealed, dusting may occur.

9.1.15 External works

External works, including drives and paths, shall have appropriate finishes.

Drives and paths should be:

- within a maximum ±10mm deviation measured using a 2m straight edge with equal offsets; however, localised falls into gulleys and channels are acceptable
- designed and constructed to minimise the potential for standing water.

One hour after rain has stopped, areas of temporary standing water should not be deeper than 5mm or exceed 1m². Temporary standing water is not permitted adjacent to entrance doors.

Also note:

- Displacement and variations in surface levels, including scuffing and pitting, may arise due to settlement, natural ground movement and traffic.
- When checking flatness, the slope required for drainage on drives should be taken into account.

Drainage covers should:

- align with the adjacent ground or surface finish (for channels, the cover should be set below the adjacent ground)
- be positioned so that the difference in height between the cover and adjacent hard surfaces allows for future settlement.

Wall and ceiling finishes

CHAPTER 9.2

This chapter gives guidance on meeting the Technical Requirements for internal wall and ceiling finishes.

NHBC

Raising Standards. Protecting Homeowners

9.2.1 Compliance

Also see: Chapter 2.1

Wall and ceiling finishes shall comply with the Technical Requirements.

Wall and ceiling finishes that comply with the guidance in this chapter will generally be acceptable.

9.2.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- Schedule of finishes.
- Plaster thickness, mix and special requirements.
- Installation details of vapour checks behind dry lining.
- Fixing specification.
- Extent and detail of tiled surfaces.
- Location of services adjacent to tiled surfaces.

9.2.3 Plastering

Also see: Chapter 8.1

Plastering shall provide an adequate substrate for the decorative finish.

Materials for plastering should be in accordance with BS 8481 and those listed in Table 1.

Where plaster is intended to contribute to fire resistance or sound insulation, overall performance should be in accordance with the building regulations.

Table 1: Materials for use in plastering

Plasters	BS EN 13279	'Gypsum binders and gypsum plasters'.
	BS 5270-1	'Specification for polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with gypsum building plasters'.
Metal laths and beads	BS 405	'Specification for uncoated expanded metal carbon steel sheets for general purposes'.
	BS EN 13658-1/2	'Metal lath and beads. Definitions, requirements and test methods'.

The background should be:

- given an appropriate treatment before plastering, in accordance with BS 8481
- suitably finished to provide an adequate key
- checked to ensure adequate and even suction
- sufficiently even to provide a reasonably flat plaster finish (excessive 'dubbing out' should be avoided).

Mixed background materials and associated differential movement can lead to cracks and should be avoided. Suitable precautions should be taken, e.g. using metal lathing.

Metal beads should be used to provide edge protection, and be fixed with zinc-plated fasteners, as recommended by the manufacturer.

Table 2: Recommended treatments for substrates

Surface	Treatment
High-density clay, or concrete bricks and blocks and dense concrete (including soffits)	Suitable bonding treatment, hacking, spatterdash, or stipple.
Mixed backgrounds, e.g. concrete with bricks/blocks	May require expanded metal to provide key for plastering and to reduce the effects of differential movement.
Lightweight concrete blocks	Plaster should not be stronger than recommended by the blockwork manufacturer.
Autoclaved aerated concrete blocks	Plastering should be conducted in accordance with the manufacturer's recommendations, accounting for the moisture content of the blocks.
Normal clay brickwork and concrete block	May require raked joints or the use of keyed bricks.
Plasterboard	Guidance is contained in BS 8212.

Where services are to be concealed by plaster, they should be:

- completed and tested before plastering
- protected against the adverse effects of chemical action or thermal movement.

To avoid surface cracking; metal lathing or wire netting should be used where there is an insufficient depth of plaster.

The plaster mix should be:

- as specified, or as recommended by the plaster manufacturer for the particular location and use
- appropriate for the strength and surface characteristics of the background
- an appropriate quality for the intended finish
- checked to ensure undercoats and finishing coats are compatible
- applied by suitably trained operatives (specifically where plastic compound finishes are used)
- of a type that does not include Portland cement and gypsum plaster in the same mix.

When plastering:

- completed work, especially timber, chipboard and glazing, should be protected from damp and damage
- in cold weather, follow the guidance in chapter 3.2 'Cold weather working' (plasterwork damaged by frost should be removed and replaced)
- dubbing out should be conducted well in advance of the application of the first coat
- surfaces should be dry, clean and free from laitance, grease, loose material or substances likely to prove harmful to the bond or the intended finished appearance of the plaster
- ensure plaster is thoroughly mixed but avoid prolonged mixing
- avoid mixing excessive quantities of plaster (plaster should not be retempered)
- the background surface of each coat should be fully set (the surface should not be overworked, and adequate time should be left between coats to allow strength and suction to develop)
- the number of coats should be sufficient to achieve a reasonably plane finish
- finished surfaces, reveals, soffits to openings, external angles, etc. should be in accordance with Chapter 9.1 'A consistent approach to finishes'
- the plaster should be applied to a thickness, excluding dubbing out, in accordance with Table 3.

Table 3: Plaster thickness

	Surface to be plastered	Minimum number of coats	Thickness of plaster
Walls	Metal lathing	3	13mm (nominal from lathing)
	Brickwork	2	13mm maximum
	Blockwork	2	13mm maximum
	Plasterboard or concrete	1	Sufficient to provide a crack-free surface
Ceilings	Concrete	2	10mm maximum
	Plasterboard	1	Skimcoat

9.2.4 Dry lining

Dry lining shall provide an adequate substrate for the decorative finish. Issues to be taken into account include:

a) installation
b) vapour control
c) detailing and support
d) fixing.

Installation

Dry lining should:

- not be started until the building is substantially weatherproofed
- be programmed so that finishes are applied as soon as possible after completion
- provide performance in accordance with building regulations where it contributes to fire resistance
- ensure that gap sealing is specified where necessary to prevent draughts.

Table 4: Standards relevant to dry lining

BS EN 520	'Gypsum plasterboards. Definitions, requirements and test methods'.
BS 8212	'Code of practice for dry lining and partitioning using gypsum plasterboard'.

Vapour control

Vapour control layers should be used to reduce the risk of interstitial condensation, and be installed in accordance with:

- Chapter 6.2 ‘External timber framed walls’
- Chapter 7.1 ‘Flat roofs and balconies’
- Chapter 7.2 ‘Pitched roofs’.

Detailing and support

Support should be provided to plasterboard in accordance with Table 5.

Table 5: Frequency of support for plasterboard

Board thickness (mm)	Maximum timber support centres (mm)	Intermediate noggings required	Perimeter noggings required
9.5	400	No	Yes
	450	Yes	Yes
12.5	400	No	Yes
	450	No	Yes
	600	Yes	Yes
15	600	No	Yes*

* unless floor joist manufacturer’s or plasterboard manufacturer’s guidance state that no perimeter noggings are required.

When fixing boards:

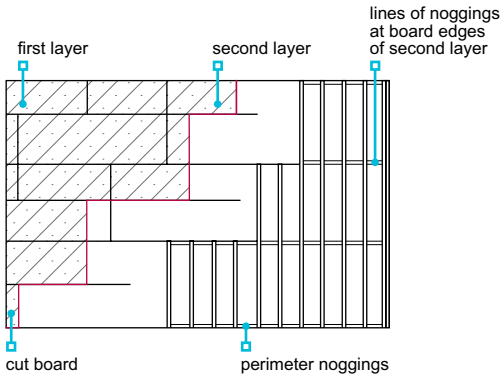
- damaged boards should not be used
- they should be fixed face side out, appropriate for plastering or directly applied finishes
- cut edges should finish over a support or nogging (though are permitted, where necessary, at perimeters)
- there should be adequate support for light points, socket outlets and other service installations
- openings for services and electrical outlets should be accurately cut (gaps in vapour control layers should be taped and sealed)
- ceiling boards should be staggered to minimise any risk of cracking.

Joints between boards should be neatly formed, flush, and suitably finished:

- with scrim tape or paper tape, where boards are to be plastered
- with tape, and filled, where boards are not to be plastered (tapered edge boards should be used for directly applied finishes), or
- as recommended by the manufacturer.

Where double layers of plasterboard are used, they should:

- be positioned so joints are staggered between layers
- have the first layer fully fixed and have all cut edges supported
- have the second layer supported on all edges with noggings provided to suit.



Dry lining should be:

- completely taped and filled at board joints and at the abutments to ceilings and internal walls
- finished to an appropriate standard and in accordance with Chapter 9.1 ‘A consistent approach to finishes’.

Fixing

Plasterboard should be fixed to:

- timber using plasterboard nails or dry wall screws
- metal using dry wall screws, or
- masonry using adhesive dabs.

Where insulated dry lining is used, nailable plugs should be specified in accordance with the manufacturer’s recommendations, and at a minimum of two per board.

Nails or screws should not project above the board surface and should be:

- 10mm minimum from paper-bound edges
- 13mm minimum from cut ends of boards
- 6mm minimum from edges of timber members.

Table 6: Acceptable fixing centres and fixings

Fixing	Location and spacing	Coating
Nail	Walls and ceilings: approximately 150mm centres (eight per linear metre)	Hot dip galvanised, zinc electroplated or sheradised steel
Screw	Ceilings: approximately 230mm centres (eight per two linear metres) Walls: approximately 300mm centres (five per linear metre)	Zinc electroplated or black phosphate (or to the board manufacturer's recommendations)

Table 7: Acceptable fixing lengths

Board thickness (mm)	Nail length (mm)	Screw length (mm) into timber	Screw length (mm) into steel
9.5	30	32	22
12.5	40	36	22
15	40	36	25

Where dry lining is fixed with adhesive dabs, it should be:

- securely fixed and filled at external and internal corners, including door and window openings
- filled with jointing compound where required, at gaps around service points, electric sockets, light switches, etc.
- installed with a continuous ribbon of adhesive to the perimeter of external walls, and around openings and services, to prevent air infiltration.

Adhesive dabs should be at 300mm centres measured vertically, and in accordance with Table 8.

Table 8: Dabs according to board dimensions

Thickness of wall board (mm)	Width of wall board (mm)	Dabs per board (rows)
9.5	900	3
9.5	1200	4
12.5	1200	3

Dry lining to receive ceramic wall tiling should be supported in accordance with Table 9 or the guidance given in BS 8212.

Table 9: Board fixing guidance for walls to receive ceramic tiles

Description	Board thickness (mm)	Support centres (mm)	Additional support	Maximum height (mm)	Comments
Timber frame (including stud walling)	12.5, 15	400-450 600	No Timber noggings 600mm centres (measured vertically)	3 600 3 600	
Timber battens	12.5, 15	400	Battens at head, base and intermediate positions not exceeding 1200mm centres	3 600	
Direct bond	9.5	450 dabs of adhesive in rows	Horizontal dabs at mid-storey height	3 600	Complete at least 10 days before tiling
Independent steel stud lining, 48mm or 60mm	2 x 12.5	400	Mid-point support	3 000	
48mm metal stud partitions 70mm metal stud partitions 146mm metal stud partitions	15 2 x 12.5 each side, or 2 x 15 each side 15 2 x 12.5 each side, or 2 x 15 each side 2 x 15 each side	400 400 400 400 600	 Additional stud at 300mm up to tile height	2 700 3 600 3 600 3 600 3 600	

9.2.5 Ceramic wall tiling

Ceramic wall tiling shall provide a surface adequate for its location and intended use (including appearance and durability).

Where a fixed shower or showerhead fixing is provided over a bath, at a height that will permit persons to stand under it:

- a screen or other suitable means of containing the water should be provided
- surfaces which will become regularly wetted should be tiled or have an appropriate alternative water-resistant finish.

Backing surfaces for tiling should:

- be in accordance with Table 9 and BS 8212
- be strong enough to support the weight of the adhesive and tiling (where separate coats are used, they should be well bonded)
- provide an adequate mechanical key
- be sufficiently even to achieve an even and plane tiled surface
- provide adequate and reasonably consistent suction
- be rigid and stable to avoid differential movement; where this may occur, precautions should be taken, e.g. metal lathing or wire netting fixed across junctions
- be moisture resistant, where designed for wetting to occur
- be dry, clean and free from laitance, grease, loose material or any substance likely to affect the bond or finish
- be reasonably even (i.e. not have gaps greater than 3mm for thin bed adhesives or 6mm for thick bed adhesives, when using a 2m straight edge).

Where the backing surface contains soluble salts, and where cement mortar is used as an adhesive, precautions should be taken, such as the use of mortar with sulfate-resisting cement.

Gypsum plasters should not be used where:

- repeated or persistent heating occurs, e.g. on flues or near heat sources
- repeated or persistent wetting may occur.

Backgrounds may be improved by:

- raking out masonry joints
- hacking and scratching
- applying a bonding agent (particularly on very smooth and dense surfaces).

Tiles should be appropriate for their location and intended use. When specifying tiles, consideration should be given to:

- surface finish
- size and thickness
- colour
- edge shape
- fittings (coves, skirtings, etc.)
- accessories (soap tray, paper holder, hooks, etc.).

Tiles should be:

- fixed in accordance with manufacturers' instructions
- suitable for the location, intended use and background; their weight on lightweight plaster should not exceed 20kg/m^2
- fixed according to the background, using cement mortar or proprietary adhesive
- solidly bedded in water-resistant adhesive on a moisture-resistant background, where frequent wetting occurs.

Table 10: Standards for tiling

BS EN 14411	'Ceramic tiles. Definition, classification, characteristics, assessment and verification of constancy of performance and marking'.
BS EN 12004	'Adhesives for ceramic tiles'.
BS EN 13888	'Grouts for tiles. Requirements, evaluation of conformity, classification and designation'.

When tiling:

- courses should be straight and even to form a plane and regular surface, especially around fittings and fixtures
- there should be no cut or unfinished tiles at exposed edges or external corners
- joints should be even and cut neatly
- spacing should be sufficient to allow for expansion
- up to sanitary fittings and fixings, the sealing method should be in accordance with the design and account for movement
- proprietary water-resistant grouting should be used in accordance with the manufacturer's recommendations.

Appropriately designed movement joints should be:

- built into tiling at centres at a maximum of 4.5m, vertically and horizontally
- provided at vertical corners in large tiled areas
- located at junctions where there are variations in surfaces or backgrounds
- 1-2mm where tiles are without spacer lugs.

Grouting should be:

- as specified in the design, including mix and colour
- cement-based epoxy resin or a proprietary product
- waterproof in and around shower enclosures and where tiling can be saturated.

Floor finishes

CHAPTER 9.3

This chapter gives guidance on meeting the Technical Requirements for floor finishes, including:

- **integral insulation**
- **screeds**
- **ceramic, concrete and similar tiles**
- **flexible sheet and tiles**
- **woodblock**
- **asphalt.**

NHBC

Raising Standards. Protecting Homeowners

9.3.1 Compliance

Also see: Chapters 2.1, 5.1, 5.2, 6.4 and 8.1

Floor finishes shall comply with the Technical Requirements.

Floor finishes which comply with the guidance in this chapter will generally be acceptable (structural floors should be in accordance with the relevant Standards chapter).

9.3.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- Schedule of finishes.
- Screed thickness and mix.
- Details of sound insulating floors.
- Extent and detail of tiled surfaces.
- Location of services adjacent to tiled surfaces.
- Details of staircase finishes.

9.3.3 Insulation

Thermal and acoustic insulation shall provide appropriate performance, and be suitable for the intended location and use.

Materials and constructions which are in accordance with building regulations are generally acceptable.

Suitable sound insulation materials include:

- flexible material
- mineral fibre quilt insulation
- board material for use under screeds (e.g. impact sound duty (ISD) grade pre compressed expanded polystyrene)
- proprietary products which have been assessed in accordance with Technical Requirement R3.

Table 1: Thermal insulation materials

Material	Standard	Grade or description
EPS (expanded polystyrene)	BS EN 13163	70
PUR (rigid polyurethane)	BS 4841	For use under screeds
PIR (rigid polyisocyanurate)		
Fibre building board	BS EN 622	Insulating board (softboard)
Proprietary material	Technical Requirement R3	

9.3.4 Screed

Also see: Chapters 3.2 and 8.1

Non-structural floor screeds shall be adequate for the location and intended use, and provide a suitable background for floor finishes. Issues to be taken into account include:

a) installation
b) screed thickness
c) screed over insulation.

Installation

Before screeding, background surfaces should be:

- clean and free of debris (e.g. dust and gypsum removed); concrete should be wetted and brushed
- suitably prepared to provide an adequate mechanical key, where bonded screeds are required, cement grouting or a bonding agent should be specified to provide adequate adhesion.

Damp proofing should be completed before screeding starts.

Screeding should not take place in weather conditions which could adversely affect the finished construction, and:

- should be scheduled to allow suitable drying time before following trades
- in hot or dry weather, precautions should be taken to prevent the screed surface drying out too quickly
- in cold weather, screeds should not be installed (screed damaged by cold should be removed and replaced).

Non-structural screed should be:

- installed to the specified thickness and provide an even surface, suitable for the intended finish in accordance with the relevant British Standards and the floor finish manufacturer's recommendations
- of a suitable sand cement mix (generally between 1:3 and 1:4½ cement:sand). Where deeper than 40mm, concrete may be used
- (where the floor is to include a monolithic slab) installed within three hours of the concrete sub-floor being poured.
- mixed using only proprietary additives that have been assessed in accordance with Technical Requirement R3
- thoroughly compacted, where required by the design, using either a heavy tamper, mechanical compactor or vibrator.

Proprietary non-structural screeds should be installed in accordance with the manufacturer's recommendations.

Surface sealers or hardeners should only be used in accordance with the manufacturer's instructions.

Where services are bedded in the screed:

- there should be a minimum 25mm of cover over the highest point of pipes and insulation
- provision should be made for the thermal movement of water pipes
- pipes should be protected against chemical attack (e.g. by using purpose-made sleeves or ducts).

Non-structural screed over underfloor heating should:

- be sub-divided into bays not exceeding 40m2, with a maximum length of 8m, or installed per room
- have expansion joints which are consistent with those in the slab.

Where concrete floor slabs are to serve directly as a wearing surface without an additional topping, they should be in accordance with BS 8204-2 and power floated.

Completed floor finishes should be protected against damage from traffic.

Standards relevant to screeding include:

BS 8204	'Screeds, bases and in-situ floorings. Code of practice'.
BS 8201	'Code of practice for installation of flooring of wood and wood-based panels'.
BS 8203	'Code of practice for installation of resilient floor coverings'.

Non-structural screed thickness

Thickness of cement and sand screeds should be in accordance with with Table 2.

Table 2: Thickness of non-structural screed

Method of laying	Minimum thickness at any point (mm)
Installed monolithically with base	12
Installed on, and bonded to, a set and hardened base	20
Installed on a separating membrane (e.g. 1000g polyethylene)	50
Installed on resilient slabs or quilts (screed reinforced with wire mesh)	65
Above services, reinforcement or insulation to services	25

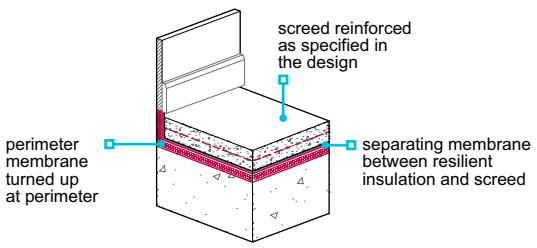
For concrete ground-bearing floors, a maximum 20mm monolithic screed may be acceptable as part of the required thickness.

Screed over insulation

Where screed is to be installed over insulation, the screed should be reinforced, and the insulation should:

- provide adequate compressive strength to support wet construction screeds and floor loads
- be tightly butted and, where required, turned up at perimeters to prevent cold bridging
- be separated from the screed by a membrane (the membrane should be compatible with the insulation, and have joints lapped and taped, and be turned up at the perimeter).

Sound insulating floating floors should be in accordance with building regulations.



9.3.5 Ceramic, concrete, terrazzo and similar tile finishes

Tile flooring shall provide a suitable wearing surface for the location and intended use.

Before tiling is started:

- ensure that the substrate is sufficiently dry (generally, six weeks for concrete bases and three weeks for screed is adequate)
- ensure the substrate is reasonably true and flat (±3mm using a 3m straight edge), and installed to falls where required
- differences in level should be dubbed out
- the surface should be clean and free from laitance, dirt, dust, grease and materials incompatible with the adhesive.

When installing tiles to floors:

- they should be bedded on a solid bed of mortar or proprietary adhesive, of a thickness appropriate for the material
- the manufacturer's recommendations should be followed where proprietary adhesives are used
- they should be arranged to minimise cutting and to provide joints which are straight, neat, and of even width
- accessories, such as covings and skirtings, should match the tile pattern, and be fixed so that joints are aligned with those in the floor
- they should be installed with minimum 3mm joints, unless otherwise specified by the manufacturer.

Where tiles are to be fixed to a wood-based substrate:

- the floor should be designed to take the additional loads of tiles, and any other materials (e.g. overlays)
- they should be suitable for laying over a timber base
- they should be bedded with deformable (flexible) tile adhesive, e.g. C2S1, and grouted in accordance with the manufacturer's recommendations

Timber floor decking should be:

- plywood for use in exterior conditions (minimum 15mm for joists at 400/450mm centres and minimum 18mm for joists at 600mm centres) screwed to the joists at 300mm centres with all square edges supported on joists or noggings (plywood should be installed with a 1.5-2mm movement gap between boards and at abutments, and be acclimatised to the room conditions and sealed on the underside and square edges, before laying, with a suitable sealer such as polyurethane varnish) or
- chipboard floor decking overlaid with minimum 10mm plywood suitable for exterior conditions, acclimatised, sealed and fixed as previously indicated, or proprietary separating/decoupling layers, tile backer boards or tile bedding reinforcement sheets used in accordance with the manufacturer's recommendations.

Movement joints should be:

- provided around the floor perimeter and at rigid upstands, where tiled areas are wider than 2m
- used to separate bays at 8-10m centres
- a minimum of 3mm wide unless otherwise specified by the manufacturer.

Grout should be:

- cement-based epoxy resin or a proprietary product
- water resistant, where tiles may become saturated.

Standards relevant to floor finishes include:

BS 8204-3	'Screeds, bases and in-situ floorings. Polymer modified cementitious levelling screeds and wearing screeds. Code of practice'.
BS EN 13748-1	'Terrazzo tiles for internal use'.
BS EN 14411	'Ceramic tiles. Definition, classification, characteristics, assessment and verification of constancy of performance and marking'.
BS 5385	'Wall and floor tiling'.

9.3.6 Wood finishes

Also see: BS 5250 and BRE Report 'Thermal insulation: avoiding risks'

Wood and wood-based flooring shall provide a suitable wearing surface for the location and intended use. Issues to be taken into account include:

a) thermal insulation and DPMs
b) sound insulation
c) condition of the substrate
d) directly applied finishes
e) indirectly applied finishes.

Wood and wood-based flooring should be installed ensuring that:

- services beneath the floor finish are tested before the floor is installed
- underfloor heating is kept on, before and during the floor laying
- wood finishes are conditioned to the appropriate moisture content
- where required, DPMs are incorporated, in accordance with manufacturer's recommendations and the design.

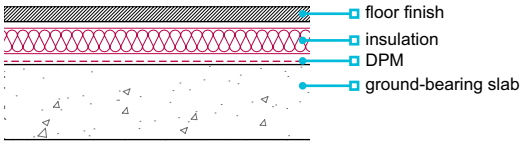
Standards relevant to wood floor finishes include:

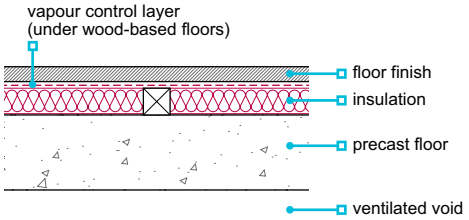
BS 8201	'Code of practice for installation of flooring of wood and wood-based panels'.
BS 1187	'Specification for wood blocks for floors'.
BS 4050	'Specification for mosaic parquet panels'.
BS 1202	'Specification for nails'.
BS 1297	'Specification for tongued and grooved'.

Thermal insulation and DPMs

Methods of providing insulation include:

- insulation positioned above in-situ concrete slab (DPM required)
- insulation positioned above dry, precast system (DPM not required).





Proprietary insulated flooring should be in accordance with:

- Technical Requirement R3
- manufacturer's recommendations on vapour control layers and DPMs.

Sound insulation

Floating floor finishes should be designed and constructed to:

- isolate the floor finish from the supporting floor and walls
- avoid excessive movement or squeaking
- avoid the use of fixings which penetrate the insulation layer
- ensure there are no airpaths, especially at the perimeter.

Where flooring is to be installed on a resilient material on a separating floor, edges should be isolated from walls and skirtings by a resilient layer.

Where a floor relies on a soft floor covering to provide the minimum standard of sound insulation, the covering should be fixed permanently in position.

Condition of the substrate

Screeds or concrete to receive wood flooring should be dry. The floor should:

- be tested and the moisture content suitable, in accordance with BS 8201
- be allowed to cure for a sufficient period of time (generally two months for 50mm screed, and six months for concrete slabs), or
- have a DPM or vapour control layer incorporated in the floor construction to protect the wood finishes (moisture should not be trapped between the layers).

Screeds or concrete to receive wood flooring should:

- be free from high spots, nibs and major irregularities
- have differences in level dubbed out.

Directly applied finishes (wood blocks, parquet, wood mosaic, etc.)

Directly applied finishes should be installed:

- in accordance with the manufacturer's recommendations
- using the correct adhesives, e.g. bitumen rubber emulsion in accordance with BS 8201 or proprietary adhesives assessed in accordance with Technical Requirement R3
- using evenly spread adhesives
- according to the specified pattern, and leaving gaps around the perimeter for movement.

Screeds or concrete surfaces should be treated with a suitable primer in accordance with the adhesive manufacturer's recommendations.

Indirectly applied finishes (softwood boarding, wood-based panel products)

Indirectly applied finishes should be installed with:

- vapour control layers where required
- preservative treated battens, in accordance with Chapter 3.3 'Timber preservation (natural solid timber)'
- provision made to support heavy items, such as storage heaters and boilers
- battens fixed to prevent excessive movement
- battens spaced in accordance with Table 3.

Table 3: Spacing of battens for indirectly applied floor finishes

	Thickness of finish (mm)	Maximum batten centres (mm)
Chipboard (type P5)	18/19	450
	22	600
Plywood	15	450
	18	600
Oriented strand board (type OSB3)	15	450
	18/19	600
Other types of floor	In accordance with the manufacturer's instructions.	

Chipboard and oriented strand board should be fixed to battens:

- with flathead ring shank nails or screws
- with fixings 2.5 x the thickness of the board
- at 200mm-300mm centres at perimeters
- at 400mm centres on intermediate supports.

Plywood should be fixed to battens:

- with 10 gauge nails or screws
- a minimum of 10mm from the edges of boards
- at 150mm centres at perimeters
- at 300mm centres on intermediate supports.

9.3.7 Flexible sheet and tile finishes

Also see: BS 5250 and BRE Report 'Thermal insulation: avoiding risks'

Flexible sheet and tile finishes shall provide a suitable wearing surface for the location and intended use.

Flexible sheet and tile finishes should be:

- installed in accordance with the manufacturer's recommendations, and generally be fully bonded
- installed on a backing surface which is even and without high spots or cracks; where necessary, using a levelling underlay of a type and thickness recommended by the flooring manufacturer or in accordance with Table 4
- reasonably level and smooth, particularly at doorways and junctions
- fitted with skirtings, coves, coverstrips and other preformed components, where required, and in accordance with the manufacturer's recommendations.

Table 4: Acceptable types of underlay for boarded surfaces

Type of underlay	Minimum thickness (mm)
Hardboard	3.2
Plywood	4
Chipboard	9
Oriented strand board	6

Chipboard and oriented strand board underlay should be fixed to battens:

- with flathead ring shank nails or screws
- with fixings 2.5 x the thickness of the board
- at 200mm-300mm centres (9mm from edges)
- across the boards, at 400mm centres.

Plywood or hardboard underlay should be fixed:

- with ring shank nails or staples
- with nails/screws at least 10mm from the edge of the panel
- around perimeters, at 100mm centres (12mm from edges)
- across the sheets, at 150mm centres.

Flexible sheet flooring materials should:

- be stored in a clean and ventilated place
- not be stored in cold conditions, unless permitted by the manufacturer
- not be exposed to temperatures less than 18°C for a period of 24 hours before, or during, laying.

The substrate should be sufficiently dry to prevent adverse effects on the flooring, and where:

- there is a risk of trapping moisture or interstitial condensation, permeable finishes should be used
- flexible sheet or tile flooring is installed on ground bearing concrete floors, a DPM should be incorporated to prevent rising moisture adversely affecting floor finishes.

When installing flexible sheet or tile flooring:

- ensure underfloor services are not damaged
- it should be cut so that it fits neatly around fittings, pipes, etc.
- adhesives should be spread evenly and left for the correct period of time to ensure full bonding
- the surface should be pressed down firmly, loaded or rolled as necessary to prevent curling, lifting or bubbling
- surplus adhesive should be removed
- welded joints should be provided in accordance with the manufacturer's recommendations
- adjustment after initial contraction or expansion should be made where necessary.

Standards relevant to flexible sheet and tile finishes include:

BS EN ISO 10581	'Resilient floor coverings. Homogeneous poly(vinyl chloride) floor covering'
BS EN ISO 10595	'Resilient floor coverings. Semi-flexible/vinylcomposition (VCT) poly(vinyl chloride) floor tiles'
BS EN 650	'Resilient floor coverings. Polyvinyl chloride floor coverings on jute backing or on polyester felt backing or on a polyester felt with a polyvinyl chloride backing'
BS EN 651	'Resilient floor coverings. Polyvinyl chloride floor coverings with foam layer'
BS EN 12104	'Resilient floor coverings. Cork floor tiles'
BS 8203	'Code of practice for installation of resilient floor coverings'.

9.3.8 Asphalt finishes

Asphalt finishes shall be suitable for the location and intended use.

Asphalt should be:

- in accordance with BS 6925 (limestone aggregate)
- Grade I or II and 15-20mm thick (which applies to the floor finishes and underlay)
- applied as one coat when used as underlay for other finishes
- in accordance with the floor manufacturer's recommendations when used with a suspended floor system.

9.3.9 Staircase finishes

Also see: Chapter 6.6

Staircase finishes shall permit safe usage and be suitable for their intended use.

The rise and going should remain uniform after application of the staircase finish, including at the top and bottom of the flight.

For communal stairs (e.g. in escape routes in blocks of flats), non-slip nosings or inserts should be:

- provided where specified
- fixed in accordance with the manufacturer's recommendations.

Finishings and fitments

CHAPTER 9.4

This chapter gives guidance on meeting the Technical Requirements for finishings and fitments (including cupboards and internal trim).

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9.4.1 Compliance

Also see: Chapter 2.1

Finishings and fitments shall comply with the Technical Requirements.

Finishings and fitments which comply with the guidance in this chapter will generally be acceptable.

9.4.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers.

9.4.3 General provisions – cupboards and fitments

The builder shall provide fixed and built-in fitments in accordance with the specification.

In kitchens, the specification should allow for:

- preparation and cooking of food
- washing up, drying and storage of dishes and utensils
- storage of dry foods
- storage of perishable foods
- laundering
- storage of domestic cleaning appliances (part of which should be suitable for brooms, upright cleaners and similar equipment)
- 1m circulation space in front of all work surfaces, cupboards and appliances.

A depth of 600mm can be assumed for appliances (where intended but not provided).

Space or facilities for laundering and cleaning items may be provided outside the kitchen area.

Space should be provided for general storage, clothes, linen and bedding. Airing cupboards are required in homes which do not have central or whole home heating.

Kitchen units should be installed in accordance with the manufacturer's instructions, ensuring that they are adequately fixed to a suitable substrate.

Shelving supports should be fixed securely and so that shelves are level.

9.4.4 Finishings and internal trim

Also see: Chapter 6.8

Finishings and internal trim shall be suitable for their location and intended use, securely fixed, and finished to established standards of workmanship.

When fixing trim and components:

- they should be in accordance with the specification
- fireplace surrounds, panelling and features should be complete and suitably joined to the adjacent surfaces
- nails should be punched below the surface of timber, and holes filled
- damage should be avoided (where damage does occur, it should be made good).

Trim and finishings should be:

- sufficiently wide to mask joints around built in fitments, etc. allowing for movement and shrinkage
- fixed in accordance with building regulations (e.g. with minimum separation distances where near heat sources)
- selected and installed to give a neat appearance
- installed in accordance with the manufacturer's recommendations.

Architraves should be:

- parallel to frames and linings
- accurately mitred, or scribed, to fit tightly and neatly
- fixed with an equal margin to each frame member
- securely fixed to prevent curling.

Skirting should:

- be mitred and scribed at external and internal angles, as appropriate
- tightly abut architraves
- run level and scribed to floors.

Proprietary trim, skirting and architraves should be fixed in accordance with the manufacturer's recommendations.

9.4.5 Joinery

Wood and wood-based materials shall be of the quality and dimensions required by the design.

Joinery and the materials used should be installed to established standards of workmanship, and have no visible defects after the finish has been applied. Issues that should be taken into account include:

- fit and construction of joints (including finger joints)
- gluing and laminating
- construction of moving parts
- surface finishes.

Relevant standards include:

BS EN 942	'Timber in joinery. General requirements'
BS EN 312	'Particleboards'
BS 1186	'Timber for and workmanship in joinery'.

9.4.6 Airing cupboards, cupboards, worktops and fitments

Airing cupboards, cupboards, worktops and fitments shall be installed to provide satisfactory appearance and performance. The builder shall provide fixed and built-in fitments in accordance with the design.

Cupboards, worktops and fitments should be:

- checked to ensure they are undamaged before they are installed
- installed as shown in the design (worktops spanning between units may require additional support)
- plumb, level and scribed to wall faces, where necessary.

Cupboards should be installed ensuring that:

- doors operate freely and fit openings closely and evenly
- drawers run smoothly, and locks and catches properly engage.

Cupboards (including wall-hung units) should be securely fixed, using:

- fixings of an appropriate size, and in accordance with the manufacturer's instructions (generally, plugs and screws to masonry and screws to timber)
- the predrilled holes in units and brackets provided by the manufacturer.

Where worktops or unit panels are cut, edges should be sealed using a metal or plastic strip glued to the edge with waterproof adhesive. Alternatively, an appropriate waterproof joint may be used. Sinks and hob units which are inset in worktops, and vanity units, should be sealed with a waterproof joint.

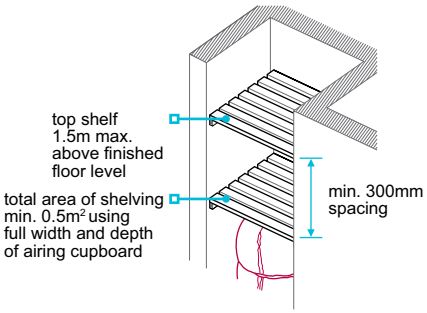
Where appropriate, gaps between fitments and wall tiling should be sealed with a waterproof joint and brought to a smooth finish.

Wardrobes should be fitted with hanging rails, and intermediate supports used where necessary to avoid bending.

Internal doors (including airing cupboard doors) should be fitted in accordance with Chapter 6.7 'Doors, windows and glazing'.

Airing cupboards should:

- be separated from other storage
- have a minimum 0.5m² of easily reached shelving suitable for the airing of clothes
- have a 300mm minimum spacing between shelves
- have a suitable heat source, such as a hot water cylinder
- not have shelving higher than 1.5m.



9.4.7 Ironmongery, prefabricated items and other materials

Ironmongery, prefabricated Items and other similar materials shall be suitable for the intended use.

Relevant standards include:

- BS EN 1935 'Building hardware. Single-axis hinges. Requirements and test methods'.

9.4.8 Protection and handover

Finishings and fitments shall be suitably protected during construction, and be undamaged at handover.

Appropriate protection should be provided to finishings and fitments (including to doors, trim, balustrades, fireplace surrounds, panelling and other special features) to ensure they are not damaged. Kitchens, including cupboards, doors, fittings and worktops, should be suitably protected.

Prior to completion and handover:

- work should be left in a clean state
- decorating should be completed in accordance with chapter 9.5 ‘Painting and decorating’
- temporary coverings and protection should be removed, and the fitments and finishings cleaned and dusted.

Painting and decorating

CHAPTER 9.5

This chapter provides guidance on meeting the Technical Requirements for painting and decorating.

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9.5.1 Compliance

Also see: Chapter 2.1

Painting and decorating shall comply with the Technical Requirements.

Painting and decorating that complies with the guidance in this chapter will generally be acceptable.

Paint finishes should be selected and applied in accordance with BS 6150 'Painting of buildings. Code of practice'.

Chapter 9.1 'A consistent approach to finishes' provides further guidance on the quality of painting and decorating finishes.

9.5.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include:

- specification of preparatory work
- schedule of finishes
- details of specialist finishes.

9.5.3 Storage

Materials for painting and decorating shall be adequately protected from the cold.

Painting and decorating materials should:

- be protected against frost before use
- not be used where they have been damaged by frost.

9.5.4 Conditions for painting and decorating

Painting and decorating shall take account of the climatic and building conditions to ensure a suitable finish.

The painting and decoration of external surfaces should not be undertaken where:

- weather conditions may adversely affect the completed work
- frost occurs, or is due to occur, before the paint has been applied or has dried
- surfaces are moist
- rain is expected before the paint dries.

When decorating internal walls:

- cold surfaces may cause problems with water-borne paints, even though the air temperature may be above freezing
- paintwork should not be adversely affected by dust
- surfaces should be free from condensation before applying paint and coatings; they should not be applied until the moisture has evaporated from the surface.

9.5.5 Timber

The painting and decorating of timber and timber-based materials shall be compatible with the species of timber, provide adequate protection and be suitable for the intended use and location. Prefabricated components and joinery shall be finished to a suitable quality, and protected.

When painting or decorating timber, the moisture content should be a maximum of 18%.

Paint and paint systems should be used in accordance with the manufacturer's recommendations, and be compatible with the surface to be decorated.

Preparation should ensure:

- door and window furniture is removed
- unsound wood, loose or highly resinous knots, etc. are cut out, replaced and made good
- raised grains, tool and machine marks are removed
- surfaces are refinished with fillers and glasspaper as appropriate
- nail holes, splits and other imperfections are stopped
- sharp arrises are rubbed down (to enable an even coating)
- surfaces are free from dirt, dust and moisture
- where there is deterioration of the primer or seal coat, surfaces are rubbed down and a second coat applied
- where joinery is delivered preprimed, priming meets the requirements in this chapter
- where joinery is prefabricated, the first coat of paint or stain is applied before fixing.

Knotting should:

- comply with BS 1336 'Specification for Knotting' (this may not be effective against heavy exudation of resin)
- be applied using a brush, or as part of the priming process for joinery.

One full round coat of primer should be applied to all surfaces to be painted, including:

- hidden surfaces of external woodwork
- cut ends of external woodwork
- rebates for glazing and backs of glazing beads.

Primers should be in accordance with BS 7956 'Specification for primers for woodwork'.

Paint or stain should be applied to external timber to provide protection and stability, even where the timber has been preservative treated (unless the preservative treatment manufacturer confirms otherwise). Primer, paint and stain finishes should be compatible with preservative treatment.

Undercoat and gloss should be applied ensuring that it provides a satisfactory finish, and:

- it is not thinned (unless recommended by the manufacturer)
- each application is a full round coat and surfaces are lightly rubbed down with glasspaper between coats
- a minimum of one priming coat, one undercoat and one finishing coat are used (unless an alternative recommendation is made by the manufacturer)
- each coat is applied within one month of the previous.

Stain and varnishes should be:

- applied as recommended by the manufacturer to provide appropriate cover
- applied to surfaces which have been suitably prepared to provide adequate adhesion and an acceptable appearance
- applied when the substrate is dry
- suitable for the species of timber.

Varnish should be applied with a minimum of three coats on interior surfaces. On exterior surfaces, varnish should be suitable for the conditions (yacht or high gloss) and applied with a minimum of four coats. Surfaces should be sanded between coats.

Stain should:

- be a two-coat system or be in accordance with the manufacturer's recommendations
- not be applied to door or window rebates which are to be glazed with linseed-oil putty.

BS EN 927-1 provides guidance on exterior wood coating systems.

Prefabricated joinery and components should be:

- protected from damage
- supplied with, or given, a coat of primer before fixing
- stored under cover and primed, where supplied untreated, as soon as possible after delivery
- reprimed where primer is damaged.

9.5.6 Steel

Steelwork shall be coated to provide adequate protection and be suitable for the intended use and location.

Decorative finishes may be applied to galvanised steel following suitable preparation with a mordant wash.

Decorative finishes applied to steelwork that has been protected by coatings (including intumescent paint for fire resistance) in accordance with Chapter 6.5 'Steelwork', must be compatible with the protective coating. The manufacturer's recommendations should be followed. Any damage to the protective coatings should be made good prior to decorative finishes being applied.

9.5.7 Walls

Walls shall be finished to provide an even and consistent appearance, to established levels of workmanship. Issues to be taken into account include:

a) external masonry and rendering

b) plaster and plasterboard surfaces.

External masonry and rendering

Paint or decorative finishes to external masonry and rendering should:

- be appropriate for the substrate, and be in accordance with the manufacturer's recommendations
- be applied to surfaces which are clean, free from dust and loose deposits
- not be applied to external brickwork or render where they could trap moisture in the construction and cause frost damage, sulfate attack or other detrimental effects.

Where bricks have no upper limit on their soluble salt content, the brick manufacturer's written agreement to the application of a finish should be obtained.

Where the decorative system is part of the weather resistance of the rendering, it should be assessed in accordance with Technical Requirement R3.

Where surfaces have varying suction, they should be stabilised with a treatment recommended by the manufacturer.

Plaster and plasterboard surfaces

A sealing coat should be applied to dry lining, and surfaces prepared for decoration, in accordance with the manufacturer's recommendations.

Plaster and plasterboard surfaces should be prepared in accordance with the manufacturer's recommendations and the design. Where plaster and skim coat is applied to plasterboard:

- surfaces should be visibly sound, without signs of powdering or crumbling
- joints should be completed and cracks, nail holes and surface imperfections filled
- the surface should be rubbed down with glasspaper and dusted, where necessary
- surfaces should be stabilised, either with a coat of thinned paint or with a sealant as recommended by the manufacturer
- a minimum of two coats of paint should be applied.

Where building boards are used, coatings should be in accordance with the board manufacturer's recommendations.

9.5.8 Wall papering

Wallpapering shall be finished to provide an even and consistent appearance, to established levels of workmanship.

Where wallpaper or coverings are used:

- surfaces should be dry, even and smooth before wallpaper is applied
- surfaces should be sized or sealed as necessary
- adhesives should be in accordance with the wallpaper manufacturer's recommendations
- they should be properly aligned and neatly fixed
- electrical switch plates should be temporarily removed and the papering accurately trimmed so that it will tuck behind the fitting upon completion.

9.5.9 Other surfaces

Surfaces shall be finished to provide an even and consistent appearance, to established levels of workmanship.

For glazing rebates in windows and doors treated with stains:

- linseed-oil putty should not be specified
- appropriate sealants should be used in accordance with the manufacturer's recommendations.

The insides of metal gutters (other than aluminium) should be painted with a suitable protective paint.

Non-ferrous pipework (e.g. copper pipes) should be painted with the normal decorative finishes.

9.5.10 Completed painting and decorating

Completed paintwork shall be to established levels of workmanship and suitably protected.

Painting and decorating should be complete, and:

- surfaces that are not intended to be painted should be free of paintmarks
- evenly applied, free from conspicuous runs or prominent brush marks, and the background or undercoat should not be visible
- where ironmongery has been removed, it should be correctly replaced
- removed and reapplied where spilt, splashed or badly applied
- protected against dirt and damage until handover.

Garages

CHAPTER 10.1

This chapter gives guidance on meeting the Technical Requirements for integral, attached and detached garages.

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10.1.1 Compliance

Also see: Chapter 2.1

Garages shall comply with the Technical Requirements.

Garages which comply with the guidance in this chapter will generally be acceptable.

10.1.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers, and include the following information:

- Location of garages.
- Relevant levels, in relation to an agreed reference point.
- Details of foundations.
- Waterproofing arrangements.
- Construction details of the roof structure and coverings.
- Construction details for walls.
- External and internal finishes.
- Services, where applicable.

10.1.3 Garage foundations

Garage foundations shall transmit all loads to the ground safely and without undue movement. Issues to be taken into account include:

a) hazardous ground
b) type of foundation required for integral/attached garages
c) type of foundation required for detached garages and blocks of garages
d) adjacent structures
e) underground services
f) provision for movement.

Garage foundations should adequately support the imposed loads, taking account of ground conditions.

Further guidance is given in Chapter 4.3 ‘Strip and trench fill foundations’.

Hazardous ground

For foundations on hazardous ground, the following chapters are relevant:

- 4.1 ‘Land quality – managing ground conditions’.
- 4.2 ‘Building near trees’.
- 4.4 ‘Raft, pile, pier and beam foundations’.

Any existing fill on the site of the garage should be examined and identified. Where any potential health hazard or risk of damage is indicated, appropriate precautions should be taken, as described in the following chapters:

- 4.1 ‘Land quality – managing ground conditions’.
- 5.1 ‘Substructure and ground-bearing floors’.

Type of foundation required for integral/attached garages

Foundations for integral or attached garages should be the same as those for the home, unless proper consideration is given to each foundation, and the possibility of differential movement between them.

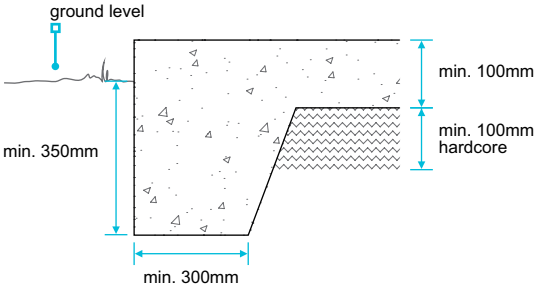
Type of foundation required for detached garages and blocks of garages

Foundations for detached individual garages or blocks of garages should avoid damage caused by differential loads and uneven settlement.

Where the ground is uniform and provides a satisfactory foundation bearing, an unreinforced edge thickened concrete slab may be used.

Unreinforced concrete slabs should:

- have a minimum thickness of 100mm
- have a minimum downstand thickening of 350mm below ground level around the whole perimeter of the slab
- have a minimum width of edge thickening of 300mm
- be constructed on 100mm minimum of properly compacted hardcore
- have dimensions not exceeding 6m in any direction – for dimensions greater than this, movement joints should be provided.



Adjacent structures

Foundations for garages should not impair the stability of the home or any other adjacent structure.

Underground services

Garage foundations that are to be above or near services should be constructed so that no excessive settlement of foundations or damage to services occurs (see Chapter 5.3 'Drainage below ground').

Provision for movement

Movement joints in foundations should be provided:

- between homes and attached garages where there is a change of foundation type or depth
- at 6m intervals where unreinforced concrete slab foundations are used.

10.1.4 Garage floors

Garage floors shall transmit all loads to either the foundations or the ground safely and without undue movement. Issues to be taken into account include:

a) bearing capacity of the ground
b) resistance of the floor to moisture from the ground
c) thickness of floor slabs
d) floor drainage
e) structural topping.

Garage floors will be acceptable where they are in accordance with:

- Chapter 5.1 'Substructure and ground-bearing floors'
- Chapter 5.2 'Suspended ground floors'
- the guidance given in this chapter.

Unless ventilation is specifically required, the void beneath a garage floor which is suspended precast concrete may be unventilated where:

- the floor has adequate durability
- the ground beneath is well drained
- there is unlikely to be a build-up of soil gases.

Bearing capacity of the ground

Where the depth of fill exceeds 600mm, concrete floors should be in accordance with Chapter 5.2 'Suspended ground floors' and BS 8103-1.

Supporting fill should comply with the requirements in Chapter 5.1 'Substructure and ground-bearing floors'.

Where protection is needed to prevent attack by sulfates in either the ground, ground water or fill below the slab, an impervious isolating membrane should be provided between the concrete and the ground.

Resistance of the floor to moisture from the ground

Generally, a DPM is unnecessary, except where:

- it is needed to prevent dampness entering the home, or
- the floor has to be protected against chemical attack from the ground.

Where no DPM is provided, the floor may show signs of dampness.

Where the floor is below ground level, precautions should be taken to prevent the entry of ground water, and tanking may be required.

Thickness of floor slabs

Ground-bearing floors, where provided, should not be less than 100mm thick, including a float finish.

Floor drainage

When practicable, garage floors should to be laid to falls to ensure that water or spillage is directed out of the garage via the vehicle doorway.

Structural topping

Where reinforced screeds are to be incorporated as structural topping, they should be designed by an engineer in accordance with Technical Requirement R5.

10.1.5 Garage walls

Walls for garages shall transmit all loads to foundations safely and without undue movement. Issues to be taken into account include:

a) stability of walls above ground
b) stability of walls retaining ground
c) provision for movement
d) adequate resistance to rain and ground water.

Garage walls will be acceptable where they are in accordance with:

- Chapter 5.1 'Substructure and ground-bearing floors'
- Chapter 6.1 'External masonry walls'
- the guidance given below.

Stability of walls above ground

Walls for detached garages and external walls for attached garages should:

- be not less than 90mm thick
- have adequate lateral restraint against wind loading
- in the case of walls up to 200mm thick, have piers at the corners (unless buttressed by a return) and at intermediate centres not exceeding 3m.

Stability of walls retaining ground

Garage walls retaining ground should be:

- suitable for the ground conditions
- structurally adequate.

Where garage walls act as retaining walls, they should be designed in accordance with Chapter 5.1 'Substructure and ground-bearing floors' or by an engineer in accordance with Technical Requirement R5.

Provision for movement

Movement joints in garage walls, as described in BS EN 1996-2, should be provided:

- between homes and attached garages
- where there are movement joints in foundations.

Adequate resistance to rain and ground water

To protect the wall from rising ground moisture, a DPC should be provided at a level at least 150mm above the level of adjacent ground.

Garage walls constructed from a single leaf of masonry, such as brickwork or blockwork approximately 100mm thick, will not be impervious to wind-driven rain and consequently could become damp.

In areas of severe exposure, single leaf walls may require a high standard of workmanship and possibly surface treatment to prevent an unacceptable level of rain penetration.

Where a garage is integral or attached, the design should ensure that dampness cannot enter the home.

Where a wall is below ground level, precautions should be taken to prevent the entry of ground water by:

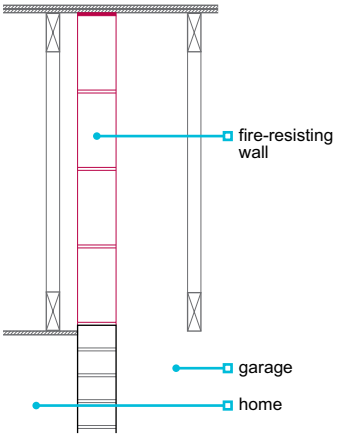
- tanking (see Chapter 5.4 'Waterproofing of basements and other below ground structures')
- the use of DPCs and DPMs
- drainage of ground behind the wall.

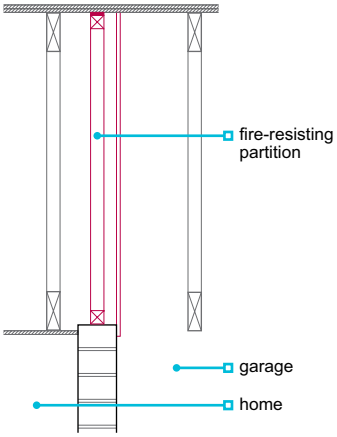
10.1.6 Resistance to fire spread

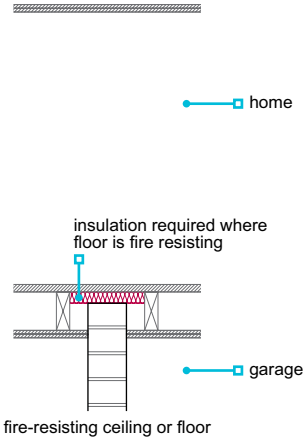
Garages shall be constructed so as to prevent fire spread to the home from the garage.

Fire resistance between homes and integral or attached garages, may be provided by:

- a wall in brickwork, blockwork or fire-resisting studwork up to the underside of the roof covering
- a half-hour fire-resisting floor or ceiling
- constructions where nominal half-hour fire resistance can be proven.







10.1.7 Security

Garages shall be constructed to provide reasonable security against unauthorised entry, in particular where garages are linked.

Where garages of different ownership are linked, walls should prevent direct access from one garage to another.

10.1.8 Doors and windows

Garage doors and windows shall be adequate for their purpose. Issues to be taken into account include:

a) robustness
b) ease of operation.

Doors and windows will be acceptable where they are in accordance with Chapter 6.7 'Doors, windows and glazing'.

Robustness

Frames should be selected and fixed having taken into account the type and weight of the garage door.

Ease of operation

Proprietary doors and door gear should be installed in accordance with the manufacturer's recommendations.

Care should be taken to ensure that garage doors are in proper working order at handover.

10.1.9 Garage roofs

Garage roofs shall satisfactorily resist the passage of rain and snow to the inside of the building, support applied loads and self-weight, and transmit the loads to the walls safely and without undue movement. Issues to be taken into account include:

a) holding down
b) bracing
c) detailing at abutments
d) movement
e) adequate disposal of rainwater.

Garage roofs will be acceptable where they are in accordance with:

- Chapter 7.1 'Flat roofs and balconies', or
- Chapter 7.2 'Pitched roofs'.

Holding down

To prevent uplift, flat roofs and, where necessary, pitched roofs should be provided with holding-down straps at not more than 2m centres where the roof members bear on the supporting wall. Straps should have a minimum cross-section of 30mm x 2.5mm, be at least 1m long and have three fixings to the wall.

Bracing

The building designer should specify all bracing. Trussed rafter roofs should be braced in accordance with Chapter 7.2 'Pitched roofs', unless the roof is designed and braced in accordance with PD 6693-1.

All timber bracing to trussed rafters should be at least 100mm x 25mm in section and nailed twice to each trussed rafter. Nailing should be 3.35mm (10 gauge) x 65mm long galvanized round wire nails.

Detailing at abutments

Precautions should be taken at abutments between a garage roof and the main building or between stepped garages, including:

- flashings and weatherproofing that allow for differential movement
- cover flashings formed from metal or other approved material
- cavity trays that divert water from inside the cavity to the external surface of the roof.

Movement

Movement joints in foundations and the structure should be continued through roof coverings and be provided with appropriate weather protection.

Adequate disposal of rainwater

The provision of rainwater should be in accordance with building regulations.

Individual roofs, or combinations of roofs that drain from one to another, with a total area greater than 6m^2, should have a rainwater drainage system.

Where rainwater from a large roof surface discharges onto a garage roof, precautions should be taken to prevent premature erosion of the lower surface.

Rainwater should not discharge from the roof directly to a drive or path.

For details on the design of rainwater disposal systems, reference should be made to the following chapters, as appropriate:

- 7.1 'Flat roofs and balconies'
- 7.2 'Pitched roofs'.

10.1.10 Permanent prefabricated garages and carports

Permanent prefabricated garages and carports shall be suitable for their intended purpose.

Permanent prefabricated garages and carports should:

- have appropriate foundations
- be structurally adequate
- provide appropriate weathertightness
- provide adequate separation between linked garages of different ownership.

Prefabricated garages should be erected in accordance with the manufacturer's recommendations.

Particular care should be taken to ensure adequate holding down of carports and other light structures against wind action.

10.1.11 Services

The provision of any service or appliance within a garage shall be in accordance with relevant regulations. Issues to be taken into account include:

a) protection of water services against frost
b) provision of electricity
c) risk of fire or explosion.

Where services or appliances are provided in garages, they should comply with the guidance below and with the following chapters, as appropriate:

- 5.3 'Drainage below ground'
- 8.1 'Internal services'.

Protection of water services against frost

A rising main should not be located within a garage.

A water supply or outlet in a garage should have adequate provision for isolating and draining down.

Pipes should be insulated and located so as to minimise the risk of freezing.

Provision of electricity

The provision of electric lighting and socket outlets in a garage is at the discretion of the builder.

All electrical installations should comply with BS 7671 'Requirements for Electrical Installations. IET Wiring Regulations'.

Risk of fire or explosion

Installation in a garage of an oil or gas burning boiler or heating appliance should be in accordance with any relevant statutory regulations.

Drives, paths and landscaping

CHAPTER 10.2

This chapter provides guidance on meeting the Technical Requirements for drives, paths and landscaping, including:

- **private roads**
- **shared private drives**
- **private drives**
- **car parking areas.**

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10.2.1 Compliance

Also see: Chapter 2.1

Drives, paths and landscaping shall comply with the Technical Requirements.

Drives, paths and landscaping that comply with the guidance in this chapter will generally be acceptable.

In this chapter 'home' includes a house, bungalow, flat or maisonette. The 'garden area' is the land within the curtilage up to 20m from the habitable parts of the home (i.e. not garages/outbuildings). This distance is measured from the external walls.

All works should be completed in accordance with:

- the design, and
- the ground remediation statement (where applicable).

Formation levels should be set out in accordance with the design.

10.2.2 Provision of information

Designs and specifications shall be produced in a clearly understandable format, include all relevant information and be distributed to the appropriate personnel.

All works relating to drives, paths and landscaping should be fully specified.

Designs and specifications should be issued to site supervisors, relevant specialist subcontractors and suppliers.

10.2.3 Stability

Precautions shall be taken to ensure stability of the ground.

Where the ground may become surcharged during construction, precautions should be taken to ensure stability.

Gabion and timber structures should not be used to provide support to homes, garages, roads, drives, car parking areas or drainage systems.

Retaining structures that give support to the foundations of a home should be completed before work starts on the construction of the foundations of the home.

10.2.4 Freestanding walls and retaining structures

Freestanding walls and retaining structures shall be adequate for their intended purpose.

Freestanding walls should be in accordance with:

- BS EN 1996-1 'Design of masonry structures'
- BRE Good Building Guide 14.

Retaining structures should be in accordance with:

BS EN 1992	'Design of concrete structures'.
BS EN 1996	'Design of masonry structures'.
BS EN 1997-2	'Geotechnical design. Ground investigation and testing'.
BRE Good Building Guide 27	'Building brickwork and blockwork retaining walls'.

All retaining structures, more than 600mm high, should be designed by an engineer in accordance with Technical Requirement R5.

Where timber structures more than 600mm high are used for retaining ground in boundary situations, they should be designed with a desired service life of 60 years.

Where planters are provided, they should be designed to support the volume of retained soil and the plant species.

10.2.5 Guarding and steps

Retaining structures and steps shall be adequately guarded and allow safe use.

Guarding should be provided where:

- structures are retaining land more than 600mm high to which people have access
- a retaining structure is more than 600mm high and the dimension from the top of the retaining wall to the higher ground level is less than 300mm, or
- a path is adjacent to a vertical difference in level of more than 600mm (including where ground adjacent to the path falls away at an angle of more than 30° from the horizontal).

The guarding should:

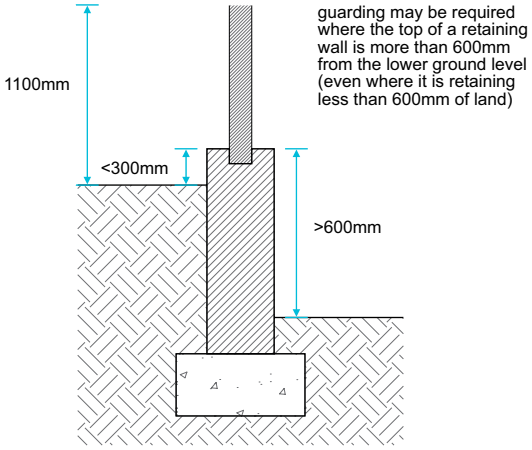
- be a minimum of 1100mm high
- not be readily climbable by children
- not allow a 100mm diameter sphere to pass through.

External steps that are not considered under building regulations should:

- have a maximum rise of 220mm
- have a minimum going of 220mm
- be reasonably uniform.

A handrail should be provided where the total rise of a flight of external steps is more than 600mm and the going of individual steps is less than 600mm.

Guidance for the provision of handrails to steps that form an accessible approach can be found in supporting documents to building regulations.



10.2.6 Drives, paths and landscaping

Appropriate access (including private roads, shared private drives, private drives, car parking and paths) shall be provided to and around the home. Issues to be taken into account include:

a) general construction considerations
b) drainage
c) construction details
d) minimum sub-base thickness
e) house paths and patios.

Homes should be provided with suitable access through the provision of private roads, shared private drives, private drives, car parking areas and paths, as appropriate.

General construction considerations

Private roads, shared private drives, private drives, car parking areas and paths should comply with relevant building regulations. Where abutting the home, they should be at least 150mm below the DPC, and laid to falls away from the home (unless a channel or other suitable means of collection and disposal is provided).

All vegetable matter should be removed from the area of the proposed works.

Only suitable fill material comprising clean, well-consolidated crushed rock, hardcore, slag or concrete should be used to make up levels.

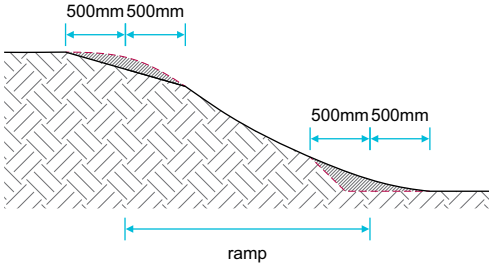
Sub-bases should be mechanically consolidated in layers not exceeding 225mm.

Finished ground levels should be compatible with:

- DPC levels
- cover levels of drainage access points
- depth of underground services (gas, electricity, water and drains)
- adjacent surfaces.

Private roads, shared private drives and private drives should:

- be appropriate for the loads
- provide reasonable access to and from a garage or car parking area
- have a maximum gradient of 1:6
- where the gradient is more than 1:10 and the gradient changes, have suitable transition lengths to reduce the risk of vehicles grounding.



Underground drainage or services that are below a private road, shared private drive, private drive, car parking area, path or patio should be protected against damage, as described in Chapter 5.3 ‘Drainage below ground’.

Edge restraint or kerbing should have a profile and foundation, which is suitable to form a permanent supporting edge for the expected vehicle loads on the road or drive.

Pedestrian access should be provided via a path within the curtilage of each home to the main entrance and the secondary entrance where present:

- Where entry to the home can be gained directly from a garage, a path to a secondary access door is not required.
- Where the secondary entrance is to a mid-terrace home or ground floor flat, a path to a secondary access door is not required.
- Where a garage, carport or car parking area is provided within the curtilage, a path should be provided to it from the home.

Where appropriate, a drive can be regarded as a path for the provision of access.

Paths should have a maximum slope of 1:6. On steeper sloping ground, steps may be required.

Table 1: Suitable path widths

Location and use	Minimum width of hard standing (mm)	Minimum overall width (mm)
Within curtilage to main entrance, or any entrance designated by Building Regulations.	900	900
Paths used for the removal of refuse to the collection point.	750	900
Paths adjoining a home (with hard standing 100mm or more from the wall of the home).	450	700
All other cases.	450	600

Drainage

Private roads, shared private drives and private drives should have adequate rainwater drainage and disposal.

Paved areas should:

- have vertical alignment, finished levels, transition arrangements and gradients in accordance with the design
- have surfaces with adequate falls, cross-falls and drainage to ensure that surface water is suitably drained
- have sub-base levels with the same longitudinal gradient and cross-fall as the finished level
- have surfaces not flatter than 1:40 or have a camber of 1:40 where no fall is available to avoid ‘flat spots’
- have surfaces with a minimum finished fall of 1:80 where they form private drives and paths
- drain away from the home (and garage), or drain to a channel or other suitable means of collection and disposal adjacent to the home
- not drain surface water from private areas onto adopted areas
- not be within 2m of a soakaway.

Where paving slabs are laid abutting drainage channels and gully grates, etc., the upper surface of the paving slab should be set approximately 5mm above the grating.

Where it is intended to use porous or permeable surfaces as part, or all, of the rainwater drainage system, reference should be made to CIRIA report C522 – Sustainable urban drainage systems design manual for England and Wales.

Construction details

The construction of private roads, shared private drives, private drives and car parking areas should be constructed in accordance with the tables below, or an equivalent alternative.

Table 2a: Private road having frequent use by commercial vehicles

Construction[1]		Road type		
		Road (bituminous macadam)	Road (block pavers)	Footpath (bituminous macadam)
Sub-base	Granular sub-base material type 1 to clause 803 table 8/2 MCHW Volume 1 Series 800[2]	Table 3	Where California Bearing Ratio (CBR) is 5% or less = 150[3] Where CBR is greater than 5% = Table 3	225[3]
Base (road base)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 1 mix)	100 (0/32mm size to clause 5.2)	N/A	N/A
	Concrete designation (BS 8500-2: table 6)	N/A	N/A	N/A
Binder course (base course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 2 mix)	60 (0/20mm size to clause 6.5)	60 (0/20mm size to clause 6.5)	60 (0/20mm size to clause 6.5)
Surface course (wearing course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 3 mix)	30 (0/10mm size to clause 7.4)	N/A	20 (0/6mm size to clause 7.5)
	Hot rolled asphalt to BS 594-1	40 (designation 30% 0/14)	N/A	N/A
	Mastic asphalt to BS 1447	30 (grade S – 40% 0/10mm size)	N/A	N/A
	Concrete designation (BS 8500-2: table 6)	N/A	N/A	N/A
Bedding course	Sharp sand to BS 7533-3 category II of annex D	N/A	50	N/A
Pavers	Block pavers to BS 6717 of class markings W2, A2 and S3 (weathering, abrasion and slip/skid classes)[6]	N/A	80	N/A

Table 2b: Shared parking and associated access areas having frequent use by commercial vehicles

Construction[1]		Road type	
		Bituminous macadam	Block pavers
Sub-base	Granular sub-base material type 1 to clause 803 table 8/2 MCHW Volume 1 Series 800[2]	Table 3	Table 3
Base (road base)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 1 mix)	80 (0/32mm size to clause 5.2)	N/A
	Concrete designation (BS 8500-2: table 6)	100 grade GEN2[4]	N/A
Binder course (base course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 3 mix)	60 (0/20mm size to clause 6.5)	N/A
Surface course (wearing course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 2 mix)	30 (0/10mm size to clause 7.4)	N/A
	Hot rolled asphalt to BS 594-1	N/A	N/A
	Mastic asphalt to BS 1447	N/A	N/A
	Concrete designation (BS 8500-2: table 6)	N/A	N/A
Bedding course	Sharp sand to BS 7533-3 category II of annex D	N/A	50
Pavers	Block pavers to BS 6717 of class markings W2, A2 and S3 (weathering, abrasion and slip/skid classes)[6]	N/A	80

Table 2c: Shared drives having infrequent use by commercial vehicles

Construction[1]		Road type			
		Bituminous macadam	Concrete	Block pavers	Gravel
Sub-base	Granular sub-base material type 1 to clause 803 table 8/2 MCHW Volume 1 Series 800[2]	Table 3	Table 3	Table 3	Table 3
Base (road base)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 1 mix)	[5]	N/A	N/A	N/A
	Concrete designation (BS 8500-2: table 6)	N/A	N/A	N/A	N/A
Binder course (base course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 2 mix)	80 (0/32mm size to clause 6.4) or (0/20mm size to clause 6.5)	N/A	N/A	N/A
Surface course (wearing course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 3 mix)	30 (0/10mm size to clause 7.4)	N/A	N/A	[7]
	Hot rolled asphalt to BS 594-1	40 (designation 30% 0/14)	N/A	N/A	N/A
	Mastic asphalt to BS 1447	30 (grade S-40% 0/10mm size)	N/A	N/A	N/A
	Concrete designation (BS 8500-2: table 6)	N/A	150 grade PAV2	N/A	N/A
Bedding course	Sharp sand to BS 7533-3 category II of annex D	N/A	N/A	50	N/A
Pavers	Block pavers to BS 6717 of class markings W2, A2 and S3 (weathering, abrasion and slip/skid classes)[6]	N/A	N/A	80	N/A

Table 2d: Private drives and parking areas having use by cars and light vehicles

Construction[1]		Road type			
		Bituminous macadam	Concrete	Block pavers	Gravel
Sub-base	Granular sub-base material type 1 to clause 803 table 8/2 MCHW Volume 1 Series 800[2]	Table 3	Table 3	Table 3	Table 3
Base (road base)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 1 mix)	N/A	N/A	N/A	N/A
	Concrete designation (BS 8500-2: table 6)	N/A	N/A	N/A	N/A
Binder course (base course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 2 mix)	60 (0/20 mm size to clause 6.5)	N/A	N/A	N/A
Surface course (wearing course)	Dense bituminous macadam (100/150 pen paving grade bitumen) with crushed rock aggregate to BS 4987 (group 3 mix)	20 (0/6mm size to clause 7.5)	N/A	N/A	[7]
	Hot rolled asphalt to BS 594-1	N/A	N/A	N/A	N/A
	Mastic asphalt to BS 1447	N/A	N/A	N/A	N/A
	Concrete designation (BS 8500-2: table 6)	N/A	100 grade PAV 1	N/A	N/A
Bedding course	Sharp sand to BS 7533-3 category II of annex D	N/A	N/A	50	N/A
Pavers	Block pavers to BS 6717 of class markings W2, A2 and S3 (weathering, abrasion and slip/skid classes)[6]	N/A	N/A	50	N/A

Notes

1 In the first column, European harmonised names are used and UK names are in brackets.
2 Where a capping layer is specified, sub-base thickness can be reduced. DMRB Volume 7 Section 2 Part 2 HD 25/95 Foundations Chapter 3 Capping and Sub-base gives guidance on capping and sub-base thickness design based on CBR values with and without a capping layer.
3 Thickness is based on the provision of a geotextile membrane underneath the sub-base. Where no geotextile membrane is provided, see Table 3.
4 Bond and tack coat should be provided for bituminous mixtures in accordance with BS 4987-2 or BS 594-2.
5 Asphalt-based materials can be used as a partial replacement of a full thickness granular sub-base type 1 material.
6 Where laid to either a 90 or 45 degree herringbone pattern, the edge perimeter should be laid with one single row of stretcher bond set parallel to the edge restraint. Where block pavers are laid abutting drainage channels, gulley grates, etc. the upper surface of the block pavers should be set 3-6mm above the grating. Manufacturer's declared value markings W3 and S4 are acceptable. Where W3 is 1.0 kg/m^2 or less and S4 is 45 or more based on 'C scale unit' (for abrasion, class A2 = maximum result is 23mm, class A1 = no performance determined).
7 A 38mm thickness of graded 15/20mm unbound aggregate to BS EN 13242 (gravel), well rolled and compacted, should be used.
8 Thicknesses are in mm.
9 Reference to clauses are in relation to the relevant British Standards.

Minimum sub-base thickness

The thickness of any required capping layer and the sub-base should be determined after investigations and on-site tests have been carried out, with consideration to the:

- CBR value
- frost susceptibility of the sub-grade; where susceptible to frost, a suitable capping layer should be included below the sub-base to a depth to ensure that construction will not be affected by frost heave.

Table 3: Minimum sub-base thickness for paved areas

CBR values	Minimum thickness (mm) of sub-base (consolidated in accordance with MCHW Volume 1 clause 801, table 8/1)	
	Without geotextile underneath	With geotextile underneath
Less than 2%	N/A	300
2-3%	325	225
3-5%	250	150
5-7%	150	N/A
7-20%	100	N/A

House paths and patios

Paths and patios should be supported on a suitable sub-base such as 100mm thickness of clean, well consolidated crushed rock, hardcore (maximum size 75mm), slag or concrete, and laid on 25mm of sand blinding or 1:4 cement:sand mortar.

Concrete paths and patios should be not less than 75mm thick and have a tamped or textured finish. The concrete mix should be suitable to give a durable and frost resistant surface, as described in Chapter 3.1 'Concrete and its reinforcement'. Movement joints, not less than 10mm wide, should be provided across the full width of the path at not more than 4m centres. A movement joint is not required at the abutment with a wall unless the opposite edge of the concrete is also restrained.

10.2.7 Materials

Materials shall be suitable for their intended use. Concrete shall be of a mix design which will achieve sufficient strength for its purpose and be sufficiently durable to remain unaffected by chemical or frost action.

Sub-base material should be type 1 to clause 803 Table 8/2, MCHW Volume I Series 800.

Hot rolled and mastic asphalts and macadam should comply with relevant standards, including:

BS EN 13108-1	'Bituminous mixtures. Material specifications. Asphalt Concrete'.
BS EN 13108-4	'Bituminous mixtures. Material specifications. Hot Rolled Asphalt'.

Aggregates used in asphalt and macadam mixtures and unbound aggregate (graded 15/20mm gravel) for surfacing should comply with relevant standards, including:

BS EN 13043	'Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas'.
PD 6682-2	'Guidance on the use of BS EN 13043'.
BS EN 13242	'Aggregates for unbound and hydraulically bound materials'.
PD 6682-6	'Guidance on the use of BS EN 13242'.

Blocks, slabs, pavers, edgings, etc. should comply with relevant standards, including:

BS EN 771	'Specification for masonry units'.
BS EN 1344	'Clay pavers. Requirements and test methods'.
BS EN 1339	'Concrete paving flags. Requirements and test methods'.
BS 7533	'Pavements constructed with clay, natural stone or concrete pavers'.

Topsoil should be of a quality that will not present a hazard to users of the garden area. BS 3882 and the Contaminated Land Exposure Assessment (CLEA) guidelines provide advice on determining the suitability of topsoil.

10.2.8 Garden areas within 3m of the home

In order to provide for adequate access to and utility immediately around the home areas up to 3m from the habitable parts of the home shall not be waterlogged.

Waterlogging of garden areas within 3m of the habitable parts of the home should be prevented by drainage or other suitable means.

10.2.9 Garden areas

Garden areas within 20m of habitable accommodation shall be adequately prepared, stable and provided with reasonable access.

The stability of new or existing slopes in garden areas should be determined by an engineer in accordance with Technical Requirement R5. Alternatively, the following maximum gradients should apply:

- Unsupported granular soil should be 5° less than its natural angle of repose.
- Unsupported cohesive soil should not exceed 9° (1:6).

Garden areas should have:

- old foundations, concrete bases and similar obstructions within 300mm of the finished ground surface removed
- appropriate action, such as rotavating, undertaken to restore the drainage characteristics of soil that has been compacted during construction
- ground disturbed during construction re-graded to conform to the general shape of the adjacent ground
- a minimum thickness of 100mm topsoil provided. Topsoil should not contain contaminants which may present a hazard to the occupants. Disturbed topsoil should be reinstated.

Subsoil should not be placed over topsoil. Construction rubbish and debris should be removed from the garden and other areas around the home.

Access is not required to small isolated garden areas, such as narrow strips of land at the top or bottom of retaining walls, but should be provided to other areas where appropriate by steps or other suitable means.

10.2.10 Timber decking

Also see: Chapter 3.3

Patios and decking shall be suitable for their purpose.

Timber decking, including support, should be naturally durable or treated with preservative.

Decking that is more than 600mm above ground level should be:

- in accordance with guidance published by the Timber Decking Association, or
- designed by an engineer in accordance with Technical Requirement R5.

10.2.11 Landscaping

Planting shall be completed in a manner appropriate for the site conditions and layout. Possible future damage to the home caused by planting shall be minimised.

Where trees or shrubs have been removed, are to be retained or are to be planted by the builder, precautions should be taken to reduce the risk of future damage to homes and services in accordance with Chapter 4.2 ‘Building near trees’.

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